

The 25th Annual International

 Mars Society Convention

October 5th – 8th, 2023

"MARS FOR ALL"

*An Hybrid (In-Person and Virtual) Event with the World's Top Mars Leaders and Experts*

**Questions and Requests:***conference-staff@marssociety.org*





# Convention Schedule

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| ***All Times are Arizona Time (MST / PDT)*** | **Day 1 - Thursday October 5th** |
| **Morning Plenaries -** *Arizona Ballroom* |
| **9:00 AM** | Dr. Robert Zubrin - Opening Remarks |
| **9:30 AM** | Jan Spacek- ALFA Mars: Search for the Martian biosphere |
| **10:00 AM** | Steve Benner- Astrobiology, synthetic biology, and the Search for life on Mars |
| **10:30 AM** | Kris Zacny - Drilling Deep: Search for Life on Mars |
| **11:00 AM** | Theodore Tzanetos - Ingenuity: the Martian Wright Flyer and Beyond |
| **11:30 AM** | Amy Williams - Search for Life on Mars |
| **12:00 PM** | **Lunch Break (Noon-1PM)** |
|  |
|  | **Afternoon Track Sessions** |
|  | **Settlement***MU 202 Alumni* | **Political, Financial and Philosophical A***MU 207 Gold* | **Technical A***Arizona Ballroom* | **Medical***MU 230 Pima* |
| **1:00 PM** | PLENARY: Dr. Wolfgang Fink - Mars cave and lava tube exploration (Arizona Ballroom) |
| **1:30 PM** | Acatzin Benitez- Analysis of a crews adaptation during the UK's first analog space mission | Philip Turek- Mars as a Societal Depolarizer Tool | Kent Nebergall- the Mars Age Technology Roadmap | Susan Jewell- Space Guardian GPT |
| **2:00 PM** | Kal'El Vnsatchoff- Mars Coloniation- Building a Mars Base | Marco Janssen- Port of Mars | Jonathan Huffman- Feasibility of Phobos Sample Return on 1 kg of fuel | Karoly Schosser- Applications of mondfulness-based trainings in astronautics (V) |
| **2:30 PM** | Laurence Vaughn - Full Access Long Duration Mars Station | Juliana Rinaldi-Semione- Slavery and Mars: Never the Twain Shall meet (V) | Eric Robinson- Peak Efficient Launch to Orbit using light Gas Impulse Launch | Laura Resike- Invesitigating the effects of time-delayed communications on the crew mission support working relationship |
| **3:00 PM** | Libby Hubbard- Arcology Zero | Jayden Sage-The Benefits to Earth Economy of Martian Settlement | Paul Armstrong- the Red Planet Explress | Machenka Eriksen- Disability on Mars |
| **3:30 PM** | Stuart Nelson- Concrete Steps to Mars | Chelsea Wells: International Relations for Mars Stays (V) | Nicholas Bennett- high Volume Payload Mass Flows to Mars | Susan Jewell - Mars Medical reserach |
| **4:00 PM** | Stuart Nelson- Unlocking Cuboctahedral Potential: Rib Truss Design for the Zero Hour Arcology Project | Steve McDaniel- Terraform Earth, then Mars (V) | Doug Plata -Starship Timeline | Machenka Eriksen- Disability on Mars |
| **4:30 PM** | Bryan White - Use of In-Situ Resource Utilization to Extend the Scope and Duration of Crewed Missions to Mars | Robert Dyck- Large Scale Coloniation Ship (V) | Thorsten Eschweiler- Audio Visual Entrainment Technology (AVE) Applications in Space Environments | Doug Plata - the First Off-Earth Birth - Where and When? |
| **5:00 PM** | Muhammad Akbar- Craterhab concept: A lkarge Scale human habitation soluation in the unque Martian context | Mission to Mars: Student Presentations (V) | Darian Phillips -Mars Transit Direct | Bruce Mackenzie- Mars University Introduction & Planning Meeting |
| **5:30 PM** | Manousos Chairetis: Eucratia (Earth's Polity for Space Exodus) (V) | *Open Slot* | Colin Lennox- Self Organzing Wetland Bioreactors (V) | Rishika Jayprakash- CogniSens Mars (V) |
|  | **Dinner Break (6pm - 7pm)** |
|  | **Thursday Evening Program** |
| **7:00 PM** | **Panel: How to Search for Life on Mars** at Arizona BallroomDr. Robert Zubrin, Dr. Carol Stoker, Dr. Amy Williams, Rachel Tillman, Jan Spacek**Public Demonstation of the First Space Suit Designed for Mars** - L. Kuznetz |
| **7:30 PM** |
| **8:00 PM** |
| **8:30 PM** |

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| ***All Times are Arizona Time (MST / PDT)*** | **Day 2 - Friday October 6th** |
| **Morning Plenaries** *- Gammage Theater* |
| **9:00 AM** | Nathaniel "Than" Putzig- Exploring Mars with Ground Penetrating Radar |
| **9:30 AM** | Rick Tumlinson- The New Space Revolution |
| **10:00 AM** | Mars Technology Institute Panel |
| **10:30 AM** | FMARS Crew 15 Panel |
| **11:00 AM** | HS Engineering Competition Panel (Robert, Nicole, Trudi, students) |
| **11:30 AM** | David Poston- Nuclear power for space |
| **12:00 PM** | **Lunch Break (Noon-1PM)** |
|  |
|  | **Afternoon Track Sessions** |
|  | **Political, Financial and Philosphical B** *Promenade* | **Analog Research** *Gammage Theater* | **Technical B***Sunset Lobby* | **Outreach***Love Lobby* |
| **1:00 PM** | Sandhya Rao- Asteroid Mining Techniques | Trevino/Drayson- FMARS-15 Quantitative Psychological Observations | Eric Kristoff- EVA Link- From Virtual to Analog for Science and Safety | Mission to Mars: Student Presentations |
| **1:30 PM** | Nina Kojima - Panopticon on Mars | Wayne L. White - The South Pole and Mars | Erik Bethke- Million on Mars | Mission to Mars: Student Presentations |
| **2:00 PM** | Alexander Vidyuk- How Dep Tech VC and Angel Investors Can Enable a Mars Colony | Katarina Mol - Perchlorate Tolerant Microalgae | Doug Plata - The InstaBase Demo | Alessandra Calanchi-An unexpected visitor: The man from Mars and his interplanetary moral code (V) |
| **2:30 PM** | Art Harman- Don't Waste Mars Launch Windows | Lennart Lopin- Planetary 'Hash War' Protection | Donald Jacues - The Application of Many Integrated Species as Biological Life Support Components | Karoly Schosser- Process-based behavioral interventions for enhancing performance in AMADEE20 (V) |
| **3:00 PM** | Anna Szolucha- Bringing space to the Masses | Carl Greenbaum-SSAFEHOUSE: An Undersea Settlement Before Mars (V) | *Open Slot* | Libby Hubbard- Mars for all - Arcology for all |
| **3:30 PM** | Emmanuel Petrakakis- Fro Vasco Da Gama to Mars Exploration (V) | Kshitij Mall- MDRS Crew 272: Novelty, Lessons Learned | Clay Abraham- Pioneering Bio-Manufacturing on the Red Planet | Chalres Leatherwood- The Mars Leap brings the dream of Mars to a new generation |
| **4:00 PM** | Jiang Fang- New Market Application Promotes the Process of Mars immigration | Kent Nebergall-Agile Space Analogs as Progress Accelerators | Rafal Anyszka- Rubber for Mars Missions | Ed Heisler- Hello Mars: Here We Come! |
| **4:30 PM** | Danny Quintana- Space and Ocean exploration as the Alternative to World War III | Carl Greenbaum - Autonomous Aquaponics (V) | Sam Ross- At Scale Processing for Martian Industry (V) | Md. Fahmid-Ul-Ulam- All about Mars in a nutshell |
| **5:00 PM** | Art Harman- Mars Lobbying 101 | TBD MaRS 1 Week Full Isolation at AATC Analogue Base (V) | Szabo-Kora- Advancements in Sustainable Materials for Revolutionizing Mars Exploration (V) | Narcisse Mbunzama- Enhancing STEM Education in Africa to Support Red Planet Exploration (V) |
| **5:30 PM** | Shashkova Petrovana - Mars in the generations of the Sun (V) | Mission to Mars: Student Presentations (V) | Mission to Mars: Student Presentations (V) | Jemimah Kwakuyi - Empowering Exploration: My Journey as an African Female Volunteer (V) |
|  |  |
|  | **Friday Evening Programs** |
| **6:00 PM** | **Panel: Mars Desert Research Station** at Gammage Theater |
| **6:30 PM** |
| **7:00 PM** | **Networking Reception** at Gammage Promenade(Cash Bar) |
| **7:30 PM** |

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| ***All Times are Arizona Time (MST / PDT)*** | **Day 3 - Saturday October 7th** |
| **Morning Plenaries -** *Arizona Ballroom* |
| **9:00 AM** | Dean Cheng - China & Its Space Program |
| **9:30 AM** | William Clancey- Robotically Mediated Exploration Undersea and on Mars |
| **10:00 AM** | Tiffany Morgan - Exploring Mars Together, DRAFT Plan for a Sustainable Future for Science at Mars |
| **10:30 AM** | Roberto Carlino, NASA Ames - My Time on the HERA Mars Analog |
| **11:00 AM** | James Heiser- Is the effort to settle Mars a dangerous religion? |
| **11:30 AM** | Shannon Rupert - Using desert varnish at Mars analog sites as a model for life detection on other planets |
| **12:00 PM** | **Lunch Break (12pm - 1pm)** |
| **12:30 PM** |
|  | **Afternoon Track Sessions** |
|  | **Science***MU 202 Alumni* | **Analog Research / NewSpace** *Arizona Ballroom* | **Technical C***MU 241 Ventana* | **Student Mars Debate** *MU 207 Gold* |
| **1:00 PM** | Quinn Morley- Drilling Deeper: Borebots and the Search for Life under the ice (V) | James Burk et. al. - MDRS Transalantic Crew 261 | Fedor Karpelevitch- The Case Against EVA suits | *Student Mars Debate (virtual)* |
| **1:30 PM** | Gabriella Rizzo- Missions to Mars from an Astrobiological perspective | Panel: Thunderbird School | Robert Mills - Virtual Telerobotic and AI for Mars | *Student Mars Debate (virtual)* |
| **2:00 PM** | Art Harman- Is China winning the race to the Moon? Does it Matter? | Colleen McLeod - Agriculture on Mars | John Chapin - Mars Standard Contro and Data systems (V) | *Student Mars Debate (virtual)* |
| **2:30 PM** | Holger Isenberg- Modern Mars Mysteries | AZ NewSpace Business Opportunities | Muhammad Akbar- A hybrid power-generation concept for Mars | *Student Mars Debate (virtual)* |
| **3:00 PM** | Steve McDaniel - Fast, Wide and Deep (V) | Federico Unger - Food Production for Analog Space Missions (V) | Tomasso Batacchi- Mars In-Situ Propellant Production | *Student Mars Debate (virtual)* |
| **3:30 PM** | William Gardiner-Mars Mysteries Become discoveries | Lojek/Trevino - Digitally Assessed Measurement of Stress in an Analog Astronaut Environment | Bruce Mackenzie- Live in a Mars/Lunar Settlement on Earth | *Student Mars Debate (virtual)* |
| **4:00 PM** | Ian McCann- The Uniform Mars Land Survey System | Jeff Rayner - MarsVR Update + Mars Comms Demo | Tim Heilers- Mars Unix Time: It's Time for Mars | *Student Mars Debate (virtual)* |
| **4:30 PM** | Aruna Devi- Exploration of Sulphur Using Aritifical Intelligence (V) | Boris Petrovic- Virtual Reality and Metaverse Applications for Mars Habitat Simulation and Training (V) | Sandhya Rao- to Study Radiation on Mars | *Student Mars Debate (virtual)* |
| **5:00 PM** | Sandhya Rao- To Study Carbon Dioxide and Polar Ice Caps on the Red Planet |  | Bharat Dehingia- Solar Thermal Power plant for Mars |  |
| **5:30 PM** | Carl Greenbaum- A Dragonfly for Mars (V) | Karoly Schlosser- Aquanuta CE's First Cave Diving Mission (V) |
|  | **Saturday Evening Program** |
|  |
| **6:00 PM** | **Saturday Evening Banquet** at Arizona BallroomSpeakers: James Burk, Mars Society updateShannon Nangle, CEO Circe Biotech: The Case for Biotech on MarsMARS-V - Mongolian Mars Analog Station Updateplus Awards Ceremony |
| **6:30 PM** |
| **7:00 PM** |
| **7:30 PM** |

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| ***All Times are Arizona Time (MST / PDT)*** | **Sunday October 8th** |
| **Morning Plenaries -** *Arizona Ballroom* |
| **9:00 AM** | Barbara Belvisi - Interstellar Research Lab (V) |
| **9:30 AM** | Kai Staats - A Summary of the first two crews at the sealled and pressurized SAM |
| **10:00 AM** | Dr. Shawna Pandya - Medicine for the Moon, Mars and Benefits for Earth |
| **10:30 AM** | Dr. Sara Walker - Mars: Red and Dead? |
| **11:00 AM** | Dr. Greg Autry - The Business of Space |
| **11:30 AM** | Relativity presentation |
| **12:00 PM** | Grant Bonin, CEO Gravity Lab |
| **12:30 PM** | Erik Bethke - Generative AI for Citizen Scientists |
| **1:00 PM** | Reid Stowe - Mars Ocean Analogs |
| **1:30 PM** | Dr. Robert Zubrin - Closing Remarks |
| **2:00 PM** | **END OF CONFERENCE** |

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| **26th Annual International Mars Society Convention****October 5-8, 2023** |  |
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# THURSDAY SESSIONS

## Special Presentations

**ALFA Mars - search for Martian biosphere**

**Jan Špaček‬‬‬**

**Agnostic Life Finding Association**

Human presence on Mars is contingent upon large-scale in situ resource utilization (ISRU), mining water for propellant manufacturing and astronaut consumption. Such mission architectures require the ISRU infrastructure to be operational before the first astronauts leave Earth. This ensures that Martian water will be mined, melted, and industrially processed on-site prior to human arrival, presenting an unparalleled opportunity for astrobiological research.

Analogous to Earth's glaciers retaining historic records or microscopic life forms deposited via the atmosphere from the entire globe, the mid-latitude ice on Mars might contain traces of Martian life, if it is present.

We propose using the in situ-mined water as a massive sample from which genetic molecules will be extracted using our Agnostic Life Finder (ALF). While we do not know the specific molecules Martian life holds, we are certain that the molecules necessary for storing hereditary information must be charged polymers. If any site on the Martian surface contained life within the last 100,000 years, ALF would be capable of identifying its record stored in the glacial ice.

Currently, ALFA Mars, an international team of astrobiologists, is the sole project aiming to detect life on Mars prior to human arrival. This presentation will discuss how we have surmounted technical and administrative challenges associated with the search for life on Mars. I will describe the current operational model of ALF, which involves extracting DNA from Mars analog ISRU water, and how we intend to secure funding for the continuation of the necessary research and instrument development, with or without NASA’s support.

 Visit alfamars.org for more information.

**Astrobiology, Synthetic Biology, and the Search for life on Mars**

**Steven Benner**

**Foundation for Applied Molecular Evolution**

Those setting out to explore must be convinced that they will find something. Columbus was convinced that he would find India. Hudson, the Northwest Passage. And for those seeking life living today on Mars, they need to be convinced that they have a good chance of finding it. This talk will explain why such conviction is justified.

## Settlement

[Acatzin Benitez](https://app.hubspot.com/contacts/20986322/contact/55601), Myles George Harris

Analysis of a crew's adaptation to a space-analog environment during the UK's first analog space mission

Universidad Autónoma del Estado de México

Studying human adaptation to hostile environments like space, where they are exposed to extreme conditions such as microgravity, radiation, danger, isolation, and confinement, is paramount for the success of future long-duration space missions. Analog environments offer a low-risk atmosphere, allowing the development and testing of countermeasures that can prevent potentially hazardous situations, provide a broader understanding of crew dynamics, and ultimately help improve the efficiency and safety of human space missions.

The UK's first analog space mission comprised an international crew of 5 analog astronauts, 4 women, and 1 man. Its objective was to simulate medical emergencies over a week on Lunga, an island north of Scotland. We tested the hypothesis that human performance and crew dynamics differ across days exposed to hostile environmental factors.

Crew adaptation was assessed through the Borg scale, finding that as days progressed, fatigue, isolation, confinement, and stress were variables suggesting a decline in crew wellbeing.

In technological terms, innovations in continuous health monitoring and countermeasure development against space-induced effects demand immediate attention. Within the mission, a protocol for monitoring heart rate variability was introduced, but it wasn't executed due to the physiological signal acquisition device failing when exposed to extreme environmental conditions. Therefore, for health research, analog environments are versatile. It's not just about space but also Earth, aiming at societal wellbeing.

Kal’El Vnsatchoff

Presentation Title: Mars Colonization – Building a Mars Base

Astra Nova School and STEAM Gifted Academy

An Analysis of Mars Colonization and Potential Solutions to the Challenges We May Face During the Process.

As a species, we are gearing up to expand beyond our planet and become multi-planetary. Whether it's to explore new horizons or seek refuge from climate change, our journey to Mars will mark the beginning of our existence as a space-faring species and symbolize a significant milestone in space exploration. However, colonizing Mars and establishing a semi-permanent outpost will present a multitude of challenges. There are a myriad of technical, medical, and political issues that stand in our way, almost all of which require a multi-disciplinary, resource-efficient approach in order to be mitigated. In this comprehensive research paper, I delve into the various problems we face in colonizing Mars and offer potential solutions. My proposals range from modular base sections to allow for easy expansion and a combination of automatic body scans and nanobots designed to detect cancers and osteoporosis at their earliest stages, and Martian aircraft to facilitate faster travel. The paper primarily focuses on the initial phase of Martian colonization, where the main objective is to establish a self-sustaining, resource-efficient Martian outpost that can sustain astronauts' physical and mental well-being. I have analyzed and addressed the problems chronologically and provided nomenclature and detailed explanations of the solutions.

Lawrence Vaughn

Full Access Mars Long Duration Exploration Station

Triplanetary Exploration Systems

Humanity is entering a new era of expanded interplanetary exploration in which mission capabilities must scale up to meet the demands of colonization

We have become expert at arriving at areas of interest like Jezero Crater and exploring the local vicinity, but it’s time for greater capabilities that do not depend on the launch window between Earth and Mars.

We propose a design for a single research center that is more than an important exploration site but serves as a base that has access to the entire planet for multiple missions. The chosen site will provide converged communications for a high bandwidth network with Earth. The key is to provide aviation assets that can travel everywhere on Mars. The research center will be both a spaceport and airport. Automated equipment will prepare roads, buildings and a terraformed region under a dome to allow farming and habitat for later colonists. Initially operations are managed remotely from Earth.

Libby Hubbard

Arcology Zero

Lovolution Studios

Earth is becoming less habitable as climate change and extreme weather events cause havoc. Summer of 2023, the heat dome and the urban heat island effect are causing the iconic Saguaro Cactus to die and beehives to melt. Phoenix is an epicenter of changes predicted to make the Southwest uninhabitable without a speedy transition to a zero-carbon emissions civilization.

If we can figure out a way to colonize Mars and create a low-water use, sustainable urban agricultural model, it can be the way to save Earth from a climate meltdown that is well underway. Mission to Mars and its evolutionary architectural containers designed for human flourishing on an inhospitable landscape could be a key for us to learn how to live successfully on Earth. Our task is to restructure civilization by building new vessels for human life on Earth so that Earth doesn’t become as inhospitable as Mars.

Arizona has several crucial urban laboratory experiments: Arcosanti, a prototype arcology, and Biosphere 2, a container and life-support system to live in hostile environments such as Mars or a Hot House Earth. These experiments have failed to provide an urban model that needs to be done to save Earth’s livable climate and for space exploration to occur.

Another urban experiment or the next phase of these experimental habitats is called for, which fully utilizes AI and 3D printing. AI will play a significant role in conceptual modeling, symbolic computation, robotic construction, manufacturing automation, infrastructure maintenance, resource accounting, circular economy management, and innovative tools for democratic governance within terrestrial or extraterrestrial habitats.

I invite you to a brainstorming session on how a new experiment in urban living might come about. I will start the session with a few slides illustrating the arcology concept. If, indeed, a new urban model is required for us to live in hostile environments, then what needs to happen to demonstrate a prototype for 5,000 people can be done? How do we gather the intellectual brain power and financial backing to build an innovative approach to space habitat for the good of all?

Stuart Nelson

Concrete Steps to Mars: Innovations in the Cuboctahedral Building Approach

ArcologyX

In our pursuit of sustainable habitats on Earth and Mars, the cuboctahedral building system, highlighted in "Designing Communities for Mars and Earth" at the 2022 conference, offers innovative solutions. At its core lie Arcologies – autonomous, integrated habitats. This presentation delves into designing and manufacturing the essential concrete parts for this system's realization.

Utilizing 3D printing technology, our team crafted durable PLA concrete molds. These molds, used for over 10 cycles, led to the production of 21 nodes and 68 capstan cable terminators, with spares for both. An integral component of our research was strength testing of the capstan cable terminators, ensuring their robustness and reliability in structural applications.

Our journey was marked by challenges, especially concerning equipment choice, mold design, and manufacturing hiccups. These hurdles not only deepened our understanding but prompted necessary design iterations.

From these experiences, we propose design modifications to optimize manufacturing, reduce wastage, and enhance component longevity.

In summary, this presentation charts our journey in turning the cuboctahedral building system vision into a tangible reality, ensuring we move closer to establishing sustainable Arcologies on Earth and Mars.

Bryan White

Use of In-Situ Resource Utilization (ISRU) to Extend the Duration

and Scope of Crewed Missions to Mars

Human spaceflight is a reemerging industry as international governments and private industry once again begin to contribute significant resources towards missions on both the Moon and Mars. Mars is an attractive prospect for human habitation because of its high potential for in-situ resource utilization (ISRU) performed either by automated (remote-robotic) or crewed missions. Implementing ISRU-based missions can extend mission lengths by reducing the amount of resources needed on mission start thereby allowing for increased crew capacity and both habitation and scientific equipment. Harvesting resources on-site could allow crews to extend mission times from short durations (3-months) to much longer, 6-months, to a year or more.

Extending crewed mission times through ISRU would allow scientists to perform more lengthy experiments such as biology and botany experiments that require time for organisms to go through several life-cycles, such as hydroponics, aquaculture, vertical farming, greenhouse construction, algal bioreactors, fungi cultivation, and insect and shellfish farming. Developing "closed-loop" systems is a critical goal of extending crewed missions to Mars beyond the 1-year mark.

However, developing and understanding the optimal conditions for which closed-loop ISRU systems can be constructed is currently a large unknown in the research space, with preliminary data suggesting that Mars does have many of the resources available to create construction materials as well as food, water, and oxygen for human use. In this presentation I will outline some work towards understanding the complex chemical and physical systems required to implement closed-loop ISRU systems for use in crewed missions to Mars and assess methods for predicting mission scope and success given the use of ISRU.

Stuart Nelson

Unlocking Cuboctahedral Potential: Rib Truss Design for the Zero Hour Arcology Project

ArcologyX

As part of the Zero Hour Arcology Project, we introduce a novel rib truss design utilizing the geometric advantages of cuboctahedral space to create a structurally efficient, minimally material-intensive system. Grounded in accessible engineering principles, this rib truss system offers low-cost, easily manufacturable, and reusable structural components—criteria essential for habitats on both Earth and Mars.

The design employs angled intersecting planes which occur in cuboctahedral space for effective load distribution across multiple planes. When coupled with top and bottom surfaces, these trusses become a versatile sandwich-structure suitable for applications such as flooring, and wall and window supports. Notably, the truss planes can be incrementally rotated along their length to produce curved "lumber," enhancing architectural flexibility.

All design work was completed using open-source software to democratize access to sustainable building solutions. To validate the design, small prototype parts were created using 3D printing techniques. For larger-scale prototypes, 4x8 sheets of plywood were precision-cut with CNC routers.

This rib truss system aligns with the urgency and goals of the Zero Hour Arcology Project. It not only meets immediate Earth-based construction needs but also prepares us for the challenges of building sustainable arcologies on Mars. This innovation is an important component of a universally deployable, sustainable construction methodology, setting the stage for multi-planetary habitation.

Manousos Chairetis

EUCRATIA (Earth's Polity for Space Exodus)

THELLAS SA (under creation)

EUCRACY will be the proposed interhuman polity, created and proposed for adoption and application by all fellow humans. EUCRACY will prepare and enable humanity to gather and focus all possible strengths for space exodus.

A thorough understanding that the problem that impedes and impairs humans on Earth to uniting in common beneficial goals will be given.

The solution to the problem of humanity's stagnation of progress, and working in unity towards achieving given common human goals will be justified.

The presentation/proposal will refer to historically successful polities of different eras of humanity that created a peaceful expansion for humans, showing that the most critical tool for positive peaceful human expansion is the polity believed by all persons in living in bright commons.

Finally, EUCRACY will be presented analytically and proposed as a practical created polity choice that can transfigure common human existence effort to follow its will and reach its goals. The most critical one is that our destiny directs us. Space!!!!!

## Political, Financial, & Philosophical

Philip Turek

Mars as a Societal Depolarizer Tool

The United States Republic has had a near death experience. Our society currently seems to be suffering from pernicious polarization, wherein a single political cleavage overrides other divides and becomes entrenched and self-reinforcing – an “Us” versus “Them” attitude leading to a downward spiral of anger and division. In the words of historian Daniel Boorstin, “The main points of American history were made not by what people fought over, but rather by what they agreed upon.” If the United States were to endeavor to send humans to and from Mars, then that would almost certainly qualify as a main point in American history. If Boorstin’s assertion is true, then it follows that the current pernicious polarization in the United States effectively blocks the sustained widespread bipartisan societal and political support required for such a “Humans to and from Mars” endeavor to succeed. Conversely, perhaps a “Humans to and from Mars” program can be used as a tool for enacting societal changes in the United States. If carefully implemented, these changes can potentially depolarize our society to some extent. That would be a good thing. Some implementation ideas are presented.

Marco Jannsen, Lance Gharavi

Port of Mars

Arizona State University

Port of Mars is a resource allocation game where five players must balance individual goals and achievements against the conflicting needs of maintaining shared infrastructure (called System Health) in the face of ongoing environmental, social, and technical challenges. The players as members of Generation Zero: the first group of long-term residents to arrive on the Red Planet, Players experience the challenges of life as early citizens of a Martian settlement. To survive, they must navigate between their personal ambitions and the group's needs. The game was originally developed as a card game, but now also available online at https://portofmars.asu.edu/. The game is used for research to study how people make decisions under uncertainty, education to stimulate learning about sustainability and space exploration, and outreach of the interplanetary initiative at Arizona State University. In this talk, we present the game, what we learned from it, and future plans. There will be an opportunity to play the game during the conference.

Juliana Rinaldi-Semione

Slavery and Mars: never the twain shall meet

The University of Nottingham

In efforts to settle Mars, not-for-profit, business, academic, and public sector stakeholders are rigorously investigating many considerations. These cross myriad fields, from resource management to flight dynamics, to law and governance, and beyond. Much of the discourse around settling Mars centers on reasons for doing so and the technical challenges of doing so, but there is also an understanding that how we do so matters. One aspect of how we go to Mars begins with the fundamental question of who is enabling our efforts to get there and how we are enabled to stay once we arrive.

This presentation considers the issue of modern slavery (sometimes called human trafficking) by putting space and human rights literature in conversation around two areas of concern: hardware and “social software.” This presentation is optimistic about the possibility of a “slavery-free Mars,” which would pay economic and non-economic dividends for people on Earth and Mars. But urgent and proactive action must be taken if we are to settle Mars without exporting slavery to space.

First, there is a known, high risk of slavery in the supply chains of such common space-bound hardware components as cobalt and polysilicon. Research shows that this risk exists even among the world’s largest, most reputable companies manufacturing batteries and photovoltaic power systems. This presentation proposes an approach for eliminating the risk of using tainted materials in service of settling Mars.

Second, the socio-political factors that enable slavery and other forms of exploitation in a society are well studied

in theory, we know how to prevent slavery from taking root in a society. A recent study proposing a real-world framework for multi-level resilience against slavery is especially promising if applied at the pre-nascent stage of a new society such as the one envisioned on Mars.

Jayden Sage

The Benefits to Earth Economy of Martian Settlement

The Foundation

Humanity’s settlement of Mars is essential to our survival in the long run. This narrative has always been approached from the perspective of existentialism. The emotional grandeur of interplanetary settlement occupies the rest of this narrative. For humanity to accept the monumental task of Martian settlement, one simple question needs to be addressed. This question has always been skirted and swept under the rug. It is even considered crude to ask, “What’s in it for us?” While we can look with disdain to those who ask such a vulgar question, the question is still quite valid. All attempts to avoid this 500-pound gorilla in the room, is at best, elitist and at worst, dismissive. For the global aspiration of humanity’s prosperity, it’s time we begin taking this question seriously: How will the Economy of Earth benefit from the Settlement of Mars? Once we land on a new world, yet again, a pivot of humanity will occur. There will be endless benefits to earth. The harsh environment of Mars will challenge humanity to ingenious new ways of survival, sustenance, and prosperity. Bleeding edge discoveries will be the reward for such engagement. From food production to soil reconfigurations, to food storage, to improvements in fishery and protein re-engineering, the list of food innovation will be endless. In the transportation and communication industries the sheer distance will necessitate countless efficiencies in reducing latency and travel times, across the board. Optimization of value creation, storage, transfer protocols and the ensuing systems will require reimagining. Every single one of these trailblazing innovations will optimize our processes right here on Earth. When we shift humanity to Mars, we will re-shift humanity’s presence on Earth. Our settlement of Mars will create a betterment of Earth on a scale we can’t even imagine yet.

Chelsea Wells

International Relations for Martian Stays

The concept of prolonged stays and living on Mars is inching closer to reality as missions are planned and NASA began its first Martian living simulation. While the United States still has an advantage, it is not the only country aiming to establish a lasting presence on Mars, breeding the possibility of both conflict and cooperation on the Martian surface. International relations and ‘space diplomacy’ have been crucial in managing such situations so far, and can be trusted to do so in the future. In this piece, I will describe why international relations are needed for Martian stays, the various ways in which international partnerships have impacted prolonged stays in space, how to adapt this for Mars, and long-term scenarios for international communities on the Martian surface. To do so, I will be drawing on instances of international cooperation for extended stays in space and analyzing international agreements and laws. I will also touch on the limitations of current frameworks and potential changes.

Steve McDaniel, Beth McDaniel

Terraforming Earth, Then Mars

Reactive Surfaces

Earth and Mars atmospheres have at least one thing in common - too much carbon dioxide. There are numerous technologies that might be able to attack this problem. But, Nature itself has tackled the over-abundance of CO2 chiefly using photosynthetic microbes thinly spread over vast amounts of the Earth’s surface. Using very thin layers of paint, in which are admixed such photosynthetic microbes, that we call Carbon Capture Coatings (CCC), when spread over vast amounts of man-made vertical surfaces that we call Massively-Iterated Vertical Surfaces (MIVS), we have proven that it is possible to annually-remove gigaton amounts of CO2 from Earth’s atmosphere in order to combat the march of existential climate change. We have also shown it is possible to farm another atmospheric gas, nitrogen, using virtually identical technology (NCC-MIVS). While not realistically terraforming Mars per se, we propose that the use of these two technologies on Mars may make the goal of establishing self-sustaining colonies more attainable.

Robert Dyck

Large Scale Colonization Ship

This is an updated to the presentation I made in 2021. A very large ship to carry settlers to Mars. This ship is designed to be built in Earth orbit, and travel from Earth orbit to Mars orbit and back. It will never land on any planet, so can be purpose built for space. SpaceX Starship will be used for construction, fuel, and as a taxi to carry passengers from Earth surface to Earth orbit. Another Starship will carry passengers from Mars orbit to the surface. With rotation for artificial gravity, passengers will travel in relative comfort, with cabins comparable to but smaller than ocean liners. This presentation will have better graphics, and presented in person instead of remote.

## Technical

Kent Nebergall

The Mars Age Technology Roadmap - The Good, the Bad, and the AI

MacroInvent.com

In just the past year, Artificial Intelligence has exploded in significance for mainstream users. Meanwhile, Elon Musk is planning autonomous driving, humanoid robots, and routine flights of Starship in the next three years. Nvidia is developing revolutionary data centers specifically to apply AI to scientific and industrial optimization. Meanwhile, personal AI workstation setups are also becoming more powerful, democratizing part of the progress to independent researchers.

A similar inventive convergence and attention divergence happened with the classic space age and the invention of the microchip around 1970. A society that expected moon bases by the 1980’s instead got personal computers. In the long term, a society that had grown accustomed to looking skyward for new frontiers became obsessed with information and simulation. The microscope replaced the telescope, culturally and economically. As with any technology revolution, there will be causes, effects, drivers, and hindrances from geopolitics.

By definition, science fiction is an entire genre of literature where even a single technology disruption will cause drama in the cultural and personal experience. What happens when such things become real, and what opportunities and threats await us this year? How can we prepare personally, professionally, and as an organization for such disruptions?

Jonathan Huffman

Feasibility of Phobos Sample Return on 1 kg of Fuel

Orbital Arc

Ultra-High ISP electric propulsion offers unique opportunities to break the constraints of delta-v and gain access to Mars and more distant destinations on very low fuel mass fractions, if sufficient power supplies are available. Orbital Arc is developing a cubesat-scale thruster capable of operating at 29,000 seconds of ISP. At this ISP level, spacecraft have over 14,000 m/s of delta-v at a 5% fuel mass fraction. This means that a 12-unit cubesat with 20 kg of dry mass can make a round trip from LEO to Mars and back on just 1 kg of fuel. In this talk, Orbital Arc CEO Jonathan Huffman will discuss conceptual mission parameters for making a Phobos landing and sample return attempt in a 12-unit cubesat, including discussions of commercial-off-the-shelf components capable of supporting the mission, mission timeline, likely mission cost, and an overall feasibility assessment for the plan. A question and answer period will follow the talk.

Eric Robinson

Peak Efficient Launch to Orbit – Light-Gas Impulse Launch

Green Launch Inc

With Light-Gas launch, 99% of all propellant gases can be captured and re-used indefinitely, unlike one-use rocket propellant. This recapture after each launch reduces the amount of additional rocket propellant production required for successive launches to near zero. A Green Launch is dedicated to delivering payloads to orbit from the Earth, Moon or Mars with the most efficient launch system now in development. In terms of fuel requirements, hardware cost per payload ton in orbit and total environmental impact, light gas impulse launch is the next leap forward.

Martian Green launch system accelerates vehicles to 4 km/s to deliver goods, including propellant for Starship, to Mars orbit to prepare for return to earth. If heated to 1700K, even ambient CO2 can be used to launch payloads to orbit from Mars.This presentation will follow the iterative costs of launching a sample payload to orbit from the Earth, Moon or Mars. It will compare the best case using the technologies of NASA, SpaceX and Green Launch.

Paul Armstrong

THE RED PLANET EXPRESS

Like it or not, space travel is expensive and cost control is imperative. Currently, there are many varieties of proposed spacecraft being developed with their own propulsion technology. These technologies result in estimated travel times to Mars of 38 to 180 days. This paper describes the Red Planet Express, a scheduled service of the Inner Solar System Transportation System. This transportation system merges various payloads (Humans included) onto one configurable spacecraft utilizing a fuel efficient primary propulsion system to reach Mars in 1.5 months (estimated). While infinitely configurable using standardized components, the Red Planet Express is specifically configured for use between Earth orbit and Mars. The standard trajectory is from the “Earth depot” in high orbit to the Mars high orbit depot. Depots include living quarters, rocket fuels, cargo warehouses, medical facilities, maintenance facilities and transportation modules for the SSTS. High planetary orbit is chosen for depot locations to avoid any orbital debris and other nearby satellites while keeping a reasonable transport time to/from the surface.

Nicholas Bennett

High Volume Payload Mass Flows to Mars, Moving More with Less

Unsw Acser

Unusual spacecraft logistics, demonstrated using the SpaceX Mars Project, significantly reduce the capital and propellant required on Earth and in space, for cargo and passengers. We reduce peak daily launches twentyfold, and as a bonus eliminate any need for orbital propellant depots. We reduce the total required Starships and Mars ISRU for cargo at least fourfold. Using the same number of Earth launches, we increase delivered cargo mass by 50%, fourfold when also using lunar-sourced oxygen. Three independent factors motivate making trans-Mars injections from LEO-perigee high-apogee orbits. First, Earth-Mars transfers are only feasible about 5% of the time but we can reduce the required daily launch capacity by launching to LEO every day and waiting in orbit. However, this creates the problem of supercooled propellants waiting close to the hot Earth. Placing vehicles in orbits with high apogees reduces Earth heating, eliminating propellant boil-off and any need for propellant depots. Passengers would board near the Mars departure a civil aviation-like shuttle Starship delivers them to a cluster of human-transport Mars Starships. Second, we show that oxygen in high-apogee Earth orbits is the likely preferred product for a lunar propellant supplier. Finally, in these orbits, a filled Starship can use the headstart either to make a faster transit or carry more payload (where substituting few rapidly reused tankers for many Mars Starships reduces the total Starships required). LEO perigee allows tankers to cheaply return to Earth after filling vehicles in high apogee orbits. Raising the apogee of the waiting orbit increases the benefits. In the spirit of Dr. Zubrin's 1990 NSS speech, we add a powered Earth gravity assist with crew hyperbolic orbit rendezvous to our logistic elements. This delivers human Jupiter system exploration with a crew flight time about the duration of a long-stay Mars mission.

Doug Plata

Starship Timeline

The Space Development Network

Not only is Starship development moving forward but SpaceX is developing a factory to produce a fleet of fully reusable Starships. Current Raptor 2 engine production rate suggests that SpaceX is roughly on track to produce Elon’s goal of 1,000 Starships by 2023. Many test flights of Starship variants will be necessary before then but Elon’s ambitious goal of a million settlers on Mars by 2050 is potentially doable. This presentation discusses in fair detail the timing of what we might expect and when. It is proposed that Starship development will have setbacks which will delay but not derail the goal of establishing a fully reusable SHLV. Even a partially reusable Starship will negate the need for NASA’s SLS-Orion system. Starlink and other constellations will make Starship financially viable and provide a tremendous source of revenue for Mars infrastructure. The Moon will serve as a nearly simultaneous testbed to test surface development for immediate application to Mars and lunar settlement will progress more rapidly than Mars due to its proximity and sufficient material resources. The presentation proposes that a million people on Mars is realistically possible by 2055-2060.

Thorsten Eschweiler

Audio-Visual Entrainment Technology (AVE) Providing Clinical and Physiological Mechanisms For Potential Applications in Space Environments

Since the onset of sonic and photic driving in the 20th century, the enigmatic technology of Audio-Visual Entrainment (AVE) has established itself as a meaningful way of reestablishing cerebral blood flows, calming the limbic system, restoring adrenal levels, producing somatic relaxation, restoring homeostasis, normalizing neural oscillations and neurotransmitter production. The elaborate concept of AVE comprises flashes of light and pulses of sound that stimulate brainwave rhythms and underlying mechanisms leading to different healing effects. Mind Alive Inc. has established itself as a reputable company for manufacturing sophisticated devices decades of scientific research corroborate the efficacy, credibility, and safety of the different Digital Audio-Visual Integration Device (DAVID) systems. They reflect decades of medical research and myriads of testimonials from physicians, clinicians, and the general population underscoring the efficacies of a new approach to treating neurological disorders and leading to relaxation like meditation and mindfulness. AVE devices are compact and low-cost at the same time and can be applied everywhere, even at home and on an analog Mars mission, a space capsule, a space station, floating habitats in the Venusian atmosphere, Starship, and the like.

While the 20th century saw the establishment of AVE in the scientific community, the 21st century may see clinical and physiological applications adapted into the perilous realm of space. Humanity is on the cusp of becoming a spacefaring civilization, and more humans will leave Earth in the long term. A multi-sensory neuro-entrainment system like the DAVID Delight Pro will be able to improve attention, concentration, memory, stress, and worry, among others. This research project focuses on the background of AVE, its underlying mechanisms, methodologies for potential implementation of the DAVID, expected results, and broader impacts of the technology concerning the space environment.

Darian Phillips

Mars Transit Direct

MTD is a project that utilizes an Interplanetary Transit Vehicle, aka The Hermes. It will dock to the ISS node 2 module. From For to Aft it consist of an IDA port, Bigelow Galaxy module. A Galley Lounge, NASA Dynasty module. A workout room, Bigelow Sundancer module. A cafeteria, NASA Transhab module. 5 Crew quarters, BEAM modules. A bathroom, Bigelow B330. A storage room, Bigelow Genesis I. A science lab, Bigelow Genesis II. A MAV, Pioneer Astronautics. A Mars Lander, SpaceX Green Dragon. 800 feet of fuel tank in a tri-star formation longitudinally. Approximately 30-50 SpaceX Raptor engines. Ship weight approaximately 30 million lbs wet. Its a cycler from LEO to Mars orbit. 5 man crews every 4 years. Assembly can commence 2030 or sooner, allowing a departure no earlier than 2038.

Colin Lennox

Self Organizing Wetland Bioreactors (sowbs) as a component of biological automated command and control life support systems (BACCLSS). Part 3: Sewerage and plant waste cycling for nitrogen sequestration and pathogen attenuation.

EcoIslands LLC

Typically the components used in an environmental control and life support systems (ECLSS) are mechanical, electrical, or chemical in nature, with electrical tying the pieces together. In biology parlance, they are fundamentally abiotic. They support a living system, but are not inherently biological in practice. Self organizing wetland bioreactors (sowbs) are wetlands in a vessel of some form which, when provided with a wide variety of microbial species, both aerobic and anaerobic as in an open environment, are capable of self organizing dependent on the pollutant or impacts in the incoming water. This self organization allows the wetland to also selectively deal with the pollutants, distilling or separating treatment spaces so that products can be drawn off in a consistent and stable manner. In essence, the sowb becomes a biological machine for separating a comingled stream of pollutants. The primary factors that allow for this sequential attenuation are reduction and oxidation (redox) energetic couplets. The most energetic couplets provide a selective advantage to microbes that use that couplet, followed by the next most energetic couple and so on to the least amount of energy that can be tied into a couplet and still support life. Sowbs were developed for coal mining reclamation in the Appalachian mountains and recently have moved into wastewater degradation. It is well established that natural wetlands are capable of degrading sewerage, generally through filtering particulates, providing oxygen, and hosting microbes that consume pathogens. Generally, they are inundated with too much material to complete the job, but when properly sized and scaled, constructed and natural wetlands have played a huge role in cleaning impacted waterways. In this way, a wetland in a box, which functions microbially like a natural wetland, has been shown to also filter suspended solids, satisfy chemical and oxygen demand, and degrade pathogens. As a component of a combined biotic and abiotic BACLSS, the sowb is the guts, stomach, kidneys, and respirator… for a human based habitat. With regards to nitrogen, the key macronutrient for plant growth (the key to semi-passive O2 production) the sowb is potentially capable of sequestering the N as reduced nitrogen products which are off gassed and captured. The liquid to gas dynamic of N is such that it is a primary limiter of primary productivity. Put simply, no nitrogen controls, no plants, no air, no food. Abiotically, lighting and chemical manipulation are required to provide nitrates, and we fell that sowbs ability to separate comingled wastestreams based on the redox is a method to provide useable nitrogen through very low electric requirements and provide a keystone thread to a habitats web of life.

## Medical

Susan Jewell, Tamara Pack PhD MD(c), Maria Harney MD

SpaceGuardianGPT- Empowering Exploration with an AI Confidante, Advisor and Healthcare Protector

SpaceGuradianGPT

SpaceGuardianGPT™ is a Large, Language Model (LLM) developed/designed for astronaut crews’ overall well-being and trained to assist with training crews, onboarding, and continuous monitoring crew physical, psychological, and physiological health. SpaceGuardianGPT™ will function as a “Protector-Advisor-Healthcare” Expert as a persistent crew member to ensure the optimum performance of the whole crew and serve as a “personal-centric “companion/confidante” Expert for each crew member. From the formation of a crew to mission deployment, SpaceGuardianGPT™ is integrated with the Internet-of-Things (IoT), access to pre-trained LLMs (e.g., crew biomedical and genetic data, medical/family history, psycho-socio-economic / cultural) robust long-term and short-term memory management of crew health data, mission logs, and other environmental data, provides crew members with 360º situational awareness and active suggestions during deployments. We know such a solution must respond comprehensively to numerous challenges in aerospace and astronautics training, mission deployment, and health management. We see the further development and expansion of the system to integrate many other medical modalities, such as, Personalized Pharmacist, Physical Therapist, and Psychiatrist-Psychologist to address the challenges of human factors and mental health of astronauts living in Space. SpaceGuardianGPTTM is trained on the gold standard of psychiatric care, Diagnostic and Statistical Manual of Mental Disorders (DSM V), while taking a holistic approach to health and wellbeing incorporating specialist healthcare experts, e.g., Dietician-Nutritionist. We will discuss the plans to test and validate the model in collaboration with upcoming MMAARS (Mars-Moon Astronautics Academy and Research Sciences) multi-fidelity analog astronaut training missions to Mojave Desert, Nepal Himalayas, Everest Basecamp (2024-2025) including the first series of Analog Aquanautics “Mars Medics” training missions to the underwater habitat off Florida Keyes in 2024. The team is composed of trained medical healthcare professionals and experienced analog astronauts developing space medicine technologies and human health mitigation countermeasures for long-duration spaceflight. Furthermore, the team is pioneering the field of space psychiatry-psychology including creating the first Artificial Intelligence (AI) powered platform that delivers personalized preventative, diagnostic, and therapeutic interventions for crew operating in isolated, confined, and extreme environments (I.C.E)

Karoly Schlosser

Applications of mindfulness-based trainings in astronautics - a review of utility and evidence

Humansys

The current review of the ESA SciSpace Roadmap already includes Mindfulness Training as a countermeasure that is to be explored. This paper will review and evaluate the utility and the evidence behind mindfulness-based cognitive behavioural interventions in astronautics, specifically discuss how key psychological processes contribute towards outcome variables also key in space exploration. Although the existing data is scarce, data shows both from quasi-experimental pilot studies in the space industry, and also from longitudinal controlled surveys collected during the pandemic that trait mindfulness, psychological flexibility, and perceived meaning seem to be drivers behind resilient and adaptive coping behaviours and strategies, and act as robust protective factors against the impact of isolation and foster mental health.

Laura Reiske, Dr. Kristin Miller

Investigating the effects of time-delayed communications on the crew-mission support working relationship

American Public University System

Time-delayed communication between mission support staff and astronauts during manned space missions contributes to the psychological functioning and performance of the crew. Delayed transmissions have been shown to cause increased stress and frustration levels for both parties as well as increased misunderstandings and errors in task performance. As humanity moves toward long-duration manned spaceflight to Mars, clarity of communications between Earth and astronauts is vital to task performance and the psychological stability of the crew.

We present preliminary results and lessons learned from a study of the effects of time-delayed communications within a 13-day analog mission at the Inflatable Lunar/Martian Analog Habitat (ILMAH) at the University of North Dakota. The time delay was imposed using ILMAH’s ECHO communications system. During the mission, a one-way time latency (OWTL) of 20 minutes was applied to all communications on mission days 3 - 10. We discuss initial data collected on the levels of stress and frustration between mission control and crew and the frequency of miscommunication due to the time latency and its effect on both crew performance and overall mission success. We also report on the effects of OWTL on both planned and unplanned off-nominal situations. We present communications protocols designed to alleviate the challenges of time delays and discuss best practices for effective communication among distributed teams.

Machenka Eriksen

Disability on Mars: Opening Discourse on Impairment, Chronic Illness, Disability and Aging on Mars

Disability is a topic that is often reserved for specific conversations. It isn’t a common subject one hears in discussions surrounding space exploration or exoplanetary terraforming. I have yet to read an article that brings disability to discourse about Mars. Yet disability is something every human being will experience at one point in their lifetime. Everyone is born needing assistance. Everyone becomes ill. And everyone ages. What sociocultural structures are in place to provide equitable access for individuals who become chronically ill, impaired (physically, mentally, psychologically, neurologically, emotionally), elderly or otherwise disabled? These are states of being that most certainly will occur, especially considering initial Mars exploration will be a one-way journey and will need to be addressed. If there are strategies already in place embedded into the systems and institutions on Mars, the community can be not only prepared for disability but welcome it as diversity and look at the individual capacity over and above their incapacity. What will their roles be? How will they be kept active, healthy and important parts of the collective community? Are there ways in which the concept of disability can become a concept of gift? Unique capacity? What forms of disability protection will there be? Systemic? Institutional? Legislative policy? Ethics? Combinations of these? What forms of supplies will be needed to ensure disabilities will be accommodated as needed? These questions, and many more urgently need to be discussed and concretely strategized for successful missions to and potentially permanent communities on Mars.

Doug Plata

The First Off-Earth Birth: When and Where?

The Space Development Network

The first off-Earth pregnancy and birth will represent historic moments as humans start expanding beyond Earth. However, there are many ways in which an off-Earth birth could go wrong and it will take specific effort to ensure that this event is positive. The birth could result from a coerced sexual encounter. It could be accidental. Or, it could result in fetal death requiring therapeutic abortion, a non-viable or deformed baby, or result in unethical risk factors which the baby hadn’t consent to. This presentation discusses the various locations where the first pregnancy and birth may occur and makes the case that the first pregnancy will likely occur safely in low Earth orbit and that the first birth will either occur intentionally and safely on the Moon or accidentally on the surface of Mars.

To maximize the best outcome of this historic event, a method is proposed to rapidly secure the true artificial gravity prescription for healthy gestation by about 2035 which is the year this presentation predicts will be when the first off-Earth birth will likely occur.

Bruce Mackenzie, Raksha Kammandore Ravi, Thorsten Eschweiler

Mars University Introduction and Planning Meeting

Mars University

The Mars University invites you to: a) attend Mars related webinars, b) take a Mars class, c) help develop a course or be a teaching assistant, d) be a webinar guest speaker, e) join or start a research group, or f) join our management reorganization. Mars University is an international academic and research organization enabling educational programs dedicated to extending life beyond Earth. Our mission is to unite students, researchers, and professionals from multidisciplinary sectors to educate, inspire, and empower humanity to become a space-faring community. Also, with the reorganization of our management and staff, it is an ideal time for new members to get involved and help shape the future. The Mars University has been giving on-line courses since 2020 related to Mars and Mars settlement. Classes included: Mars Agriculture, Mars Geology, Human Factors, Astrobiology, Robotics, and even Venus. (Some planned in-person classes were canceled due to the Covid pandemic.) MarsU has also sponsored web presentations and webinars. MarsU is planning future online programs, and graduate level research. MarsU is also collaborating with others in the Space Development Network, Mars Foundation, and Mars Society to plan a future research station and campus. What additional programs, courses, research or other activities would you recommend the Mars University conduct? Would you like to help? Depending on your experience and qualifications, you could participate as: student, instructor, teaching assistant, researcher, guest lecturer, social media coordinator, or a management position.

If interested or unable to attend at the scheduled time, please contact Info@Mars.University

Rishika Jeyaprakash, Sofia Pentilla, Alina Ashraf

CogniSens Mars: Enhancing Astronaut Well-being through Sensory Interventions for Interplanetary Exploration

As we venture to the Red Planet, extreme isolation is a significant concern that must be considered. It becomes an overarching factor that can severely impact and impair the ability of astronauts to work on research, projects, or just adaptations to the environment of space. As said by Tom Williams of the Human Factors and Behavioral Performance, sensory experiences (the smell of grass, the sight of a sunny day, and the feel of their feet on the ground) are one of the astronauts' most missed experiences while in space, impacting motivation and decision-making. We present a dual aspected research proposal to combat this in locations like Mars. The first aspect pertains to educational interventions designed to spread awareness of this topic, as people may brush over it, not understanding the severity. In this year of open science, we aim to impart a broader perspective on this pressing concern through foundational training modules and informative webinars. For the second part of our research proposal, we will direct our efforts toward comprehending the critical sensory experiences for astronauts' psychological well-being. This will require astronauts to undergo a series of structured evaluations, simulating diverse sensory encounters that Earth readily affords, yet space inherently precludes. The data collected can be used to create mini sensory experience kits tailored to astronauts' distinct needs. To overcome the spatial constraints, we consider employing (VR) platforms (like the Canadian EDEN project) to simulate these sensorial encounters. While important aspects of behavioral and cognitive psychology intertwine with these ideas, this idea might be another step toward eliminating future problems astronauts may face in their journey to Mars and stay there.

# FRIDAY SESSIONS

## Political, Financial and Philosophical

SANDHYA RAO

TO STUDY Asteroids and develop new space mining technologies

VIMANA NOTION AEROSPACE DESIGN TEAM

The asteroid belt is a region of space between the orbits of Mars and Jupiter where most of the asteroids in our Solar System are found orbiting the Sun. The asteroid belt probably contains millions of asteroids... To study the Asteroid belt by Radar -Asteroid Tracking Data. To develop strip mining equipment , mineral refining technology that it hopes will allow it to extract precious metals from these asteroids and return them to Earth.

Nina Kojima

Panopticon on Mars

PhD University of Glasgow, member of BIS and member of Mars Society

Charles Cockell argues that tyranny will emerge on Mars from people having control over oxygen supplies, food and water. Robert Zubrin believes that no one will ever want to go to live and work on Mars if there is any form of tyranny imposed there. How and why should we propose the ethical framework for people to live a prosperous, virtuous and happy life on Mars and how can Mars emerge as a place of opportunities when only a limited number of people can afford to buy the tickets to fly to Mars?

It goes without saying that the media will play an important role in the evolution of extraterrestrial human life, for many reasons, particularly as a tool for settlers not only to keep in touch with those on Earth but also for everyday communication. Here, the possibility of the media preventing tyranny on Mars arises. One example of this could be that settlers on Mars would live in a form of Panopticon, and their experiences could become a form of entertainment that is live streamed to subscribers on Earth (although this would be subject to a 20-minute delay, which is how long it takes for the signal to travel from Mars). If a billion people were fascinated enough, and willing to pay a monthly subscription, the income generated might well cover the costs of the mission.

In principle, Jeremy Bentham’s 18th-century Panopticon is a concept of a prison which is designed so all the prisoners are placed in the cells around the circumference and are observed by a single security guard from the centre. Prisoners don’t know when the guard is looking at them, so they consciously behave well. In the case of Mars, instead of the prison guard in the middle, there would be a camera for live streaming. Subscribers who are paying for access to the stream will be able to monitor the whole situation, thus not only possibly preventing violations between the settlers but also measuring the Martian authorities. A Panopticon would take control from individuals who might violate others’ rights, but on the other hand it would also remove a certain level of privacy and the freedom of those living in the colony. They will all have to work and deliver the right standards, following the protocol. The question is whether this would be possible to enforce. Would anyone travel for seven months to a lethal planet, and live and work there in the most challenging conditions, knowing they were being watched the entire time? However, if the live stream were limited, say, to only the working day, this might still reduce the chances of someone taking advantage and becoming a tyrant. This might also have the effect of preventing the potential for tyranny to be imposed by a benefactor who has remained on Earth. In any case, this possible solution would only work in the early stages of any Mars missions and for the first of the settlers. When the colony grows, and more people arrive, Martian society is likely to enter into a political system that will eventually establish trade with Earth. At this point, things will dramatically change.

Alexandra Vidyuk

How Deep Tech VC and Angel Investors Can Enable a Mars Colony

Space Ambition

As the aspiration for a Mars colony intensifies, the nexus between Deep Tech Venture Capitalists, Angel Investors, and organizations such as the Mars Society and the Mars Technological Institute (MTI) becomes paramount. This proposal highlights how collaborative engagement can fast-track Martian colonization. Deep Tech VCs and Angel Investors are positioned uniquely to finance and mentor transformative technologies crucial for Mars settlements. Through combined resources, they not only avail capital but also connect startups to vital networks and bestow strategic insight. With the Mars Society's advocacy and MTI's research backbone, this becomes a formidable driver for space-tech innovation. To engage more investments for the Martian program, the inclusion of private capital is pivotal. A collective effort is required to devise a technological roadmap tailored for a Mars colony. Following this, we must identify which of these technologies can be initially tested on the Moon, facilitating spin-offs for terrestrial applications.

Critical steps include:

* Collaborative Forums: Creation of platforms merging space agencies, startups, and academies, orchestrated by the Mars Society and MTI.
* Mars-centric Incubators: Propagate incubators emphasizing Mars technologies, leveraging MTI's expertise.
* Regulatory Dialogues: A synergy between the Mars Society's advocacy, VCs, and Angel Investors to navigate regulations.
* Dedicated Mars Funds: Instituting funds exclusively for Martian innovations, denoting unwavering commitment.
* Promote Public-Private Synergy: Enhance cooperation between government space factions and the private realm, unifying their visions.

By marrying the investment prowess of VCs and Angel Investors with the Mars Society's mission and MTI's technological prowess, we can pave a tangible pathway to Mars. This combined endeavor promises groundbreaking solutions, laying the groundwork for a sustainable human presence on Mars.

Art Harman

Don’t Waste Mars Launch Windows

SaveMannedSpace.com

There’s a launch window to Mars every 26 months. How have those been used—or wasted, and how will they be used in the future, according to known plans? For example, there’s no plans by NASA to use the 2024 launch window for anything. And the 2018 launch window was, in my opinion, wasted by sending InSight to Mars—science which has zero relevance to human landings, and its seismic measurements would have been an easy project for early crewed landings. That and other windows could have been used for ISRU type missions with relevance for human landings and habitation. Plans for a Mars sample return by China are shaping up, and NASA’s sample return is on shaky budgetary footing. Learn more about how past and future Mars windows have been and will be used by all worldwide space programs. Successes with Starship may soon provide an abundance of launches and allow for relatively inexpensive tests of Martian habitat designs, ISRU components and even regolith sample returns sooner than NASA could imagine. You’ll also learn how China intends to use Mars launch windows over the next couple decades. And we’ll discuss what upcoming launch windows should be used for

.

Anna Szolucha

Bringing space to the masses: How space creators and enthusiasts help SpaceX get to Mars

Jagiellonian University

This presentation will be based on my anthropological research in Boca Chica/Starbase, Texas, where SpaceX is building and testing Starship prototypes. Although much journalistic attention has been devoted to various technological aspects of this endeavour as well as the company’s CEO – Elon Musk, I delve into the part of it that is rather hidden from view from all but the most ardent space fans, namely the vibrant social world of space creators and enthusiasts.

Space creators and enthusiasts are a growing international community that creates, distributes and uses original (usually digital) content about space exploration. Space creators include 3D artists, film makers, photographers, reporters and many others who are supported by a wide network of moderators, quality checkers, transcribers and other space enthusiasts who perform a variety of everyday tasks that keep the discussion about space exploration going in the public sphere. Together, they play an important, if still not widely recognised, role in validating space travel and popularising the settlement of Mars.

As an anthropologist, I have been afforded a unique window into this world and in this presentation, I will explore how space creators and enthusiasts think about their work and the role that they play in the broader space ecosystem.

Emmanuel Petrakakis

FROM VASCO DA GAMA (1498) TO MARS EXPLORATION (circa 2038)

This document illustrates first and foremost the similarities and differences (to some extent) , between two epic Human Exploration undertakings, past and future Vasco da Gama’s journey to India and the future space human journey to Mars. The comparative between Vasco da Gama's Journey to India in 1498 and the future voyage of Humans to planet Mars! (540 years later), sheds light to other global issues. Resulting from these human explorations (India and Mars), we outline some of the significant historical changes and permanent impacts on our societies i.e. the ¨ Fall Out¨ from these milestones. We dare to compare herein , the mission architecture, the voyage, the main issues and socio/economic impact between Da Gama’s journey and the modern humans to Mars voyage (circa 2038?). This therefore is not an academic document as it is merely laying out an idea that might be the seed for further research and academia. The author only tries to encapsulate the various comparable factors between Vasco da Gama’s exploration (1498) vis a vis Mars future endeavour and relate them as positive catalysts for creating Global Economic growth and prosperity.

Jiang Fang

New market application promotes the process of Mars immigration

1. How should Mars transportation, accommodation, food, lifestyle and other products be designed? How to verify? How to iterate? How to ensure that it is reliable on Mars?

2. How should humans run and manage on Mars? What kind of Mars rules should be created so that Mars will not become a new battlefield for human beings?

3. How to complete these processes in business applications? Not in the laboratory.

Now, I have discovered new market demand reaches nearly $ 10 billion per year. The new market applications can be perfectly combined with Mars immigration, which can provide a good solution for these problems. At the same time, these new market applications will create value for tens of millions of neglecting groups each year.

DANNY QUINTANA

Space and Ocean Exploration as the Alternative to World War III

Global High Seas Marine Preserve

This paper proposes redirecting human aggression, and the destruction of the environment towards space and ocean exploration to prevent World War III. By including all major powers in space and ocean exploration, a final world war can be avoided.

Demilitarizing the global economy, by transitioning from defense spending to space and ocean exploration will create new industries and millions of jobs. Aerospace contractors have the engineering skills that can build spaceships, robots, improve propulsion systems to explore, terraform, and colonize Mars. To ensure civilization's survival, we must create a new mission for the military-industrial complex and end Russian imperial dreams. Since World War II, American and Russian foreign policies have been a humanitarian and environmental disaster. This drift to a third and final world war is a clear and present danger to life on Earth.

After the humanitarian and financial disasters of Vietnam, Iraq and Afghanistan, the United States no longer has the financial ability to embark on exploration of the solar system alone. What is proposed is converting defense industries from manufacturing intercontinental ballistic missiles and fighter planes to spaceships to explore the solar system. Similarly, navy contractors can convert from creating aircraft carrier battle groups into exploration mining vessels. The world’s navies can focus on ocean exploration, protecting marine life, preventing pollution, and combatting destructive practices like shark finning. Our global environmental problems necessitate cooperation. Space and ocean exploration offer a natural alternative to the drift toward a third and final World War. Human cooperation is not an idealized view of the world. Space and ocean exploration are practical alternatives to destructive military competition. Redirecting war industries towards exploration will demilitarize the global economy, and safeguard life on Earth. Space and ocean exploration will create hope for young people.

Art Harman

Mars Lobbying 101

The Coalition to Save Manned Space Exploration

This and next year offer excellent opportunities for YOU to lobby presidential and congressional candidates and incumbents in support of realistic space and Martian exploration budgets and plans. During the presidential primary season, you’ll find candidates and their senior staff will be traveling around the country and more accessible and happy to chat. They literally go to small town diners and civic centers. Even those who don’t win will gain additional influence and may end up in a senior administration position. Likewise, Congressional incumbents and candidates will be at local meetings and events, and happy to talk with constituents. These are valuable opportunities for you to talk about space. And Mars! You’ll learn more on how to take advantage of gaining the attention to candidates, and you’ll also learn how to most effectively talk with your elected members of Congress and their key staff. When you call a Congressional office, who should you talk to? Should you talk to the science committee staff? What’s the wrong things to say? Learn these and other topics from a former Congressional Legislative Director and campaign expert. Whether this topic is new to you or you need a refresher, you’ll learn something new and have the opportunity to ask questions.

## Analog Research

Wayne White

Author of Cold: Three Winters at the South Pole

The South Pole and Mars

After spending three Antarctic winters as the Winter Site Manager at the Amundsen-Scott South Pole Station, I wrote my book “Cold: Three Winters at the South Pole.” The book chronicles the selection, training, deployment, and the actual winter experiences of three separate crews at the South Pole. The similarities and lessons learned from a South Pole winter experience and how that may resemble future Mars colonization was the topic of my discussion for the 2022 Mars Society Convention. The presentation was a success with much interest generated both during the presentation and after. I propose doing it again for the 2023 MSC.

While the Mars Desert Research Station and other similar projects are great starts in preparing for an actual Mars mission, the South Pole’s Amundsen-Scott South Pole Station during winter has several features that make the experience more realistic. At the South Pole the short summer with 24 hours of light and milder average temperatures -18F (-22C) runs from November 1st to February 15th. The winter is the rest of the year with an average temperature of -76F (-60C.) The last aircraft departs the station around February 15th and a winterover crew with no way out will experience months of cold and darkness that few can imagine.

I will discuss issues that we now face at the South Pole and could face in upcoming Mars missions especially during colonization. Starting with crew selection, choosing the right people that are not only the best in their field but can get along with others. This is not always easy to do. I will discuss topics that some might consider mundane like food, activities, traditions, and personnel issues which loom so large during a South Pole winter and may someday loom so large on Mars.

Lennart Lopin

Planetary 'Hash-War' Protection as an Example of Decentralized Licensing Systems

The Marscoin Foundation

The remote nature of Mars necessitates a financial system tailored to its specific challenges. Traditional blockchain protocols face latency issues arising from light-speed communication constraints, rendering real-time transactions on Mars less than ideal. Moreover, the potential exploitation from Earth-based miners, equipped with advanced hardware, introduces risks such as double spends. Building on the foundation of the Martian Republic - a blockchain-based "Republic As Software" system that achieves transparency and direct participation - this paper emphasizes the evolution of its public voting system, which leverages the coinshuffle protocol. While the voting system itself is a testament to decentralized governance, our primary focus is on the innovative approach to its application. We propose using the Martian Republic's voting system for a community-based licensing process. By allowing Martians to register their mining software's public key, and subsequently seeking community endorsement via votes, miners can earn the community's trust and validation. Once endorsed, miners can then sign blocks with their digital keys. Only blocks carrying these community-approved signatures are integrated into the blockchain, while those without are dismissed. This novel approach to licensing accentuates the collective power and decision-making capability of the Martian community, ensuring that it remains decentralized and free from any central authority's undue influence. By intertwining the coinshuffle voting platform with a digital signature-based validation system, the Martian Republic not only fortifies its network against hash attacks but also enhances security and auditability across various community actions and processes. In an era of burgeoning interplanetary settlements, our approach underscores the Martian Republic's ability to ensuring that its blockchain governance remains transparent, auditable, and truly representative of its community's collective will.

Carl Greenbaum

SSAFEHOUSE: An Undersea Settlement Before Mars (V)

Discussions about “Lifeboat Mars” have become pretty common lately. Elon Musk, Stephen Petranek and others have described the settlement of Mars as a way to mitigate the many existential threats to the human race. The risks seem real enough but is Mars the first or only option?

As we follow and support efforts to land humans on Mars, a sustainable, “lifeboat” colony of 1,000 people is many decades in the future. The threats that help motivate such colonization efforts many not wait “many decades”. How about something we could build tomorrow. A survivable, independent underwater habitat with 1,000 settlers could be constructed with today’s technology and protect humanity from nearly all the existential threats motivating Mars colonization. Think about it as a blending of a cruise ship with a nuclear submarine. It can provide a stopgap solution to mitigate existential threats while serving as a research site for power, environmental control, hydroponics, aquaculture and psychological/social /governmental issues applicable to a Martian colony. An interim step between MDRS and Mars.

This presentation explores the undersea option including site selection, environmental control, power, food, and housing examples and even a sample colonist skill distribution.

If you believe humanity needs to protect itself from an extinction event and if, in spite of your enthusiasm for manned Mars missions, you realize that a Mars colony big enough to ensure the survival of humanity may be too far into the future, come learn about this undersea colony concept.

Kshitij Mall

MDRS Crew 272: Novelty, Lessons Learned

Purdue University

A crew of 7 from the cradle of astronauts, Purdue University, embarked on a rotation at the Mars Desert Research Station at the start of this year. This MDRS crew 272, dubbed as Purdue Redusters, aimed at advancing research supporting human Mars missions. Right from the internal selection process to mission training the crew had to go through a rigorous process mimicking an actual astronaut selection at a much smaller scale. The crew chose to implement a new metric to keep track of the research progress while at Purdue and named it as Mission Readiness Level (MRL). To increase the participation of students who couldn’t make it physically to MDRS, Purdue Mission Control was set up. From flying an AI drone for the first time at MDRS to taking up the challenge of using a 3D printer at MDRS, many novel research ideas were proposed and executed by the crew. Coping up with some unforeseen challenges faced by the crew is shown in this study. Recommendations and suggestions for future crews, based on the findings of Purdue Redusters, will also be presented in this study.

Kent Nebergall

Agile Space Analogs as Progress Accelerators

MacroInvent.com

For the last two decades, Mars outpost analogs like MDRS have given generations of researchers access to Mars-like conditions so they may validate procedures, equipment, and capabilities. In addition, the University Rover Challenges have given hundreds of students a working knowledge of robotic engineering. Mars analog studies have also flourished worldwide as other organizations have built facilities and programs to expand practical experience with human exploration. With Starship, human spaceflight progress in the next two decades will expand a thousand-fold. Will analog simulations keep up with reality? What can accelerate practical simulation to address the scientific, engineering, and procedural challenges of the Mars Age? The lodestar of space analog studies should be space settlement. It must include measurable and comparable results across projects, and between theory and practice. Modular systems should be created based on the areas of science, engineering, and methodology being evaluated. Industrial simulation best practices can be adapted for Mars analog work. Modular systems can also be scaled to allow participation at any level from high school classes to near-launch space operations. This will create an international talent development funnel to prepare for this thousand-fold increase in capacity. It will also democratize problem solving and participation to maximize the benefits to human civilization. Modular, repeatable, measurable, affordable, and practical systems can be built in such a way that any concept of operation can be tested, compared, and improved. A common formatting language for design, construction, resolution, and publication can simplify comparisons to find the best methods for practical operations for Mars hardware production.

Carl Greenbaum

Autonomous Aquaponics (V)

Expeditionary space missions need a steady stream of nutritious, acceptable food for the crew. Earth prepared food is suitable for small crews with access to convenient resupply. Beyond these constraints, locally grown food becomes imperative., NASA has undertaken numerous ISS experiments (VEGGIE, Advanced Plant Habitat and Aquatic Habitat) with some success.

But several critical questions remain:

* Can a system be sufficiently automated to limit crew task loading?
* Can locally grown fish food and crew food waste provide a nearly closed loop system?
* What is the resupply mass of required food supplements, consumables and equipment spares?

A small-scale Autonomous Aquaponics system has been designed to demonstrate the capacity to merge vegetable and fruit production and fish protein in an integrated, nearly closed-loop system suitable for operation on lunar and planetary surfaces with low crew task loading. Fish waste is filtered and nitrified to eliminate toxicity and make nutrients available to the plants. The plants absorb the nutrients and the clean water is returned to the fish tank. In addition to fruits and vegetables, duckweed is grown as a high protein fish food.

The system will be able to autonomously monitor and control:

* Water level, temperature, pH and electrical conductivity
* Lighting levels and duration
* Feeding schedule
* Reporting of equipment failures and out-of-bounds conditions

This Autonomous Aquaponics system permits evaluation of critical operational parameters including:

* Control system performance (OOB conditions/month)
* Task loading (minutes/month)
* Food production (kg/month)
* Water consumption (liters/month
* Power consumption (kwh/month)
* Plant nutrient and fish food mass requirements as a function of food production (kg/kg)
* Launch mass of required resupply as a function of food production. (kg/year)

The demonstration system has been designed to fit into a 2’ x 4’ x 7’ cabinet.

## Technical B

Eric Kristoff

EVA Link- From Virtual to Analog for Science and Safety

Mars Society Chicago

In 2022 the Chicago Mars Society chapter proposed the development of a system for “Digital EVA Tracking at MDRS.” This is a progress update and presentation on the system’s expansion and preliminary results. Now named EVALink, it is an integrated system to enable coordinated real-time field science between physical space analog research facilities, and virtual reality digital-twins. This will improve science, situational awareness, and crew member safety at MDRS. Integration with virtual reality extends the analog research capability to a much wider audience, while also opening the door to new scientific collaborations.

First, EVALink will help improve crew member safety. EVALink improves safety by providing long range, low power digital connectivity over ad hoc mesh network topologies. This enables short messages, such as an SOS, to be shared amongst users of the system, even if beyond line of sight. Second, EVALink will improve situational awareness. Location telemetry of crew members is automatically collected and aggregated by a computer server deployed at MDRS. There it is logged and displayed for other crew members in real time. In the event of an accident or other need for assistance, crew members will know the locations of crew members in real time. Third, EVALink will enable science collaboration between an analog astronaut on EVA, and a user in a virtual reality digital twin. For example, an analog astronaut collecting rock samples at MDRS will be able to interact with a user in a high-fidelity digital twin of the exact same location. Samples with GPS coordinates can be logged in a common database for future crews to build on past geology/biology work. We will share progress against these objectives, plans for future development, and lessons learned from preliminary testing during Crew 261.

Erik Bethke

Million on Mars: Year Two - Default Alive

Million on Mars, Inc.

The swift currents of technological and economic change can leave many ventures struggling to stay afloat. Drawing wisdom from Paul Graham's impactful phrase, "Default Alive," this talk explores the tactical pivots and hard decisions taken to keep "Million on Mars" alive and thriving.

* The Landscape: In year two, we battled a volatile web3 winter, pulling back on speculative spend, much like a Mars colony cut-off from Earth's supply ships.
* Defensive Moves: Slashed SaaS costs from $18K to $2.4K per month, accelerated web2 payments, and leveraged our game dev skills in high-trust, cash-positive work-for-hire gigs.
* Offensive Moves: Released a Game Design Editor for user-generated content and are diving into new features like rover vs. rover combat and expanded resource layers.
* Future Frontiers: Gearing up for Year 3, we're launching "Rust, Dust and Glory," a Rover vs Rover combat module aimed at making Million on Mars a fully-rounded online gaming experience. We're also implementing Natural Language support in our Game Design Editor, leveraging the latest in language model tech for streamlined, user-friendly content creation. Beyond Mars, we are setting sights on the moon's Armstrong's Leap and the Galilean moons, among other celestial bodies.

In the face of daunting challenges and extreme uncertainty, the talk digs into how we leaned into our engineering acumen, community strength, and gritty resolve to steer towards a "Default Alive" state. The takeaway: resilience and adaptability aren't just buzzwords—they're survival tools on Mars and in the competitive gaming industry.

Doug Plata

The InstaBase Demo

The Space Development Network

The Space Development Network has developed a full-scale mock-up of an initial inflatable base applicable to planetary surfaces such as the Moon and Mars. Our goal with the demo is to promote the concept that inflatables are the best choice for initial permanent bases due to volume, material safety, energy efficiency, and speed of set-up.

The InstaBase has nine different modules which provides all the functional space for an Initial Permanent Crew of eight. It could be delivered in a single Starship. Tele- and automated robots would prepare the ground beforehand and retrieve the compacted InstaBase payload. A modest amount of liquified air would easily unfold the InstaBase. Robots would then secure the InstaBase to the ground prior to full inflation to ½ atm. For shielding, on the Moon, regolith would be poured through a hole on the top of each module between two outer layers. On Mars, water would be pumped between the layers. The habitat modules would include: BedHab, BathHab, LivingHab, ArtsHab, WorkHab, Lookout Tower, two GreenHabs, and a SpinHab. Our InstaBase is large with a footprint comparable to the floor of a typical high school gymnasium. We have developed a large number of signs and a number of physical exhibits illustrating different aspects of space development. We have displayed the InstaBase mock-up and Space Fair at the National Space Society’s annual ISDC Conference.

Our Moon-Mars Analogue Base (MMAB) is a concept for a new type of analogue base that is primarily development (as opposed to exploration) oriented. It would be located within site of KSC and be close to helpful populations and resources. A plan for the development of the MMAB is described.

Donald Jacques

The Application of Many Integrated Species as Biological Life Support Components

EarthSeed, Inc.

The development of technological life support systems is a straightforward application of the scientific method, under rigidly controlled and repeatable methodology. It is expensive and resource intensive. As a result, life support systems today are still open systems into which "consumables" are regularly cycled, and selected "wastes" are cycled out. Commercial operations similarly continue to fail because of their focus on optimizing either a single species, such as tilapia, or lettuce, or a primary method such as nutrient delivery, aka, hydroponics. Each of these suffer from buildups of waste materials that require costly remediation that prevents closure of the ecology.

Nature demonstrates the principles and processes of life support around us every day, we have but to identify those principles and processes and then implement them with our technological prowess. The smooth functioning of the natural framework around us offers that if we can embrace its underlying principles, we could not only develop a more robust system for orbit and beyond, but develop future research with more people involved, and far simpler systems. I present a framework that could be applied to Habitats to shepherd multiple interacting species, rather than control the life support system, and as a result reduce costs, infrastructure, and provide greater resiliency overall.

Clay Abraham- Pioneering Bio

Manufacturing on the Red Planet

It is well established that the development of a Martian colony will rely on Earth for a variety of materials and resources. For a Martian colony to succeed in any capacity, biotechnology can be leveraged to address the lack of a manufacturing base. Microbial chemical synthesis facilitated by biotechnology is a possible mechanism to circumvent traditional Terran hydrocarbon chemical synthesis. On Earth, our current manufacturing systems use hydrocarbon derivatives due to their chemical conversion efficiency, established infrastructure, and relative abundance. On Mars, however, sending metric tons of raw hydrocarbons or refined chemicals in place of habitat materials, O2, and various other required Earth-derived materials is not advantageous due to fuselage capacity constraints. To overcome this manufacturing hurdle, biotechnology and the application of various microorganisms can be employed to jumpstart the Martian industrial base. Specifically, extremophilic anaerobes can serve as the initial pioneers of bio-manufacturing on Mars. Anaerobic psychrophiles and thermophiles offer several unique mechanistic benefits. Firstly, these organisms can utilize the Martian atmosphere. This significantly reduces the demand for precious O2 supplies, which are essential for habitat areas. Secondly, anaerobes do not require aeration equipment during culturing, and in the case of psychrophilic anaerobes, these organisms may be cultured without heavily insulated tanks. Thus, the engineering requirements of the initial bio-manufacturing process can be further simplified. Lastly, anaerobic extremophiles are more resistant to Earth-based contamination. This resistance is due to the temperatures utilized, media conditions, and chemicals produced by the anaerobic thermophiles and psychrophiles. Contamination at any point during the bio-manufacturing of chemicals on Mars can lead to lower production volumes and strain the already limited supply chain. Therefore, the application of anaerobic extremophiles to implement a bio-based manufacturing system can become the path of least resistance.

Rafal Anyszka, Li Jia, Anke Blume

Rubber for Mars Missions

University of Twente

Mars attracts more and more attention as the most habitable near-Earth planet. Its mass is lower than that of the Earth but still provides a significant gravity. It has an atmosphere that mild-down the outdoor conditions. Finally, its day lasts almost as long as a day on Earth. Therefore, it is a perfect place for extraterrestrial exploration and a potentially habitable place for humans. All these factors give hope and inspiration for future Mars colonization. However, the environment on Mars is much more hostile than on Earth. The temperature ranges from -120°C to 20°C with a daily amplitude reaching 100°C. There is no ozone layer and magnetosphere to protect against UV and particulate radiation, respectively. And also, the pressure on Mars is around 150 times lower than on Earth. Because of this, the materials used for Mars missions have to exhibit proper environmental resistance and the ability to preserve their performance in the challenging conditions of Mars.

Rubber is one of the most unique and important materials used in engineering on Earth, because of its viscoelastic properties and high mechanical-dynamic performance. Therefore, it is almost irreplaceable in many applications, like tires, sealing gaskets, or anti-earthquake building dampers. However, on Mars rubber is currently not used because of its limitations like the inability to preserve good viscoelastic properties in a very broad range of temperatures, containing volatile ingredients that can outgas in low pressure or unknown resistance to the radiation present in Mars‘ environment.

To overcome these limitations, the RED 4 MARS project [1] aims to develop butadiene (BR) / silicone rubber (VMQ) blends that can preserve viscoelastic properties in a wide range of temperatures. Both rubbers are characterized by the lowest glass transition temperature values from all elastomers, which makes them the most suitable ones to preserve elasticity at low temperatures on Mars. The designed BR/VMQ compounds are free of volatile ingredients to prevent outgassing on Mars and during space travel. Also, simulated radiation aging and low-temperature performance are tested to foresee their long-term behavior on Mars. However, blending BR with VMQ is very challenging because of their thermodynamic incompatibility. Also, the vulcanization of the blends is difficult due to the differences in the chemical structure of both elastomers. This paper aims to optimize the composition of the BR/VMQ compounds to maximize their performance in the Martian environment.

Sam Ross

At Scale Processing for Martian Industry (V)

University of Cambridge

Exploration and settlement of Mars requires the use of chemical, electrochemical and thermophysical processes operating at huge scales. Historic concept planning for Mars missions has focused on extending laboratory and pilot demonstrations to these required scales to determine the optimal design. However, this approach of small-first excludes concepts that can only be viable at large scale. These large-scale concepts are often significantly more effective and efficient than their small-scale alternatives but are also understudied and their impact on mission concepts is poorly understood. Through a family of research projects, including a Master’s thesis, a systematic study of some of these large-scale thermophysical process systems has been carried out. Dramatic improvements have been identified for a number of these processes, often with the use of technologies from terrestrial industries. For instance, approaches to reduce the energy intensity of carbon dioxide acquisition and compression by a factor of five, and of cryogenic propellant liquefaction by a factor of three, have been found and characterised. The equivalent system masses of both processes, as well as energy storage, have been reduced dramatically without the use of any unproven technologies. All of these approaches, as well as several others, are detailed and the philosophy of at-scale process engineering described.

Szilvia Szabo-Kora, Áron Selmeci MSc/MA, Soma Stenszky BSc/BA, Kinga Tamási PhD.

Advancements in Sustainable Materials for Revolutionizing Mars Exploration (V)

Aprus Space Technologies

Introduction: Human exploration and settlement of Mars is a daunting task that requires significant advancements in science and engineering to overcome the challenges associated with long-term habitation on the Red Planet. One crucial area of research is the development of sustainable materials that can withstand the harsh Martian environment and support the infrastructure needed for human exploration. In this research, we will discuss the latest advancements in materials science that have the potential to revolutionize the way we approach Mars exploration.

Materials and methods: As a diverse team consisting of experts from the fields of chemical engineering, technical informatics engineering, materials engineering, space medicine, and space biotechnology, we will present our joint research on the development of innovative materials and technologies for the construction of sustainable habitats, equipment, and infrastructure. Our interdisciplinary approach integrates the principles of materials science, nanotechnology, and biotechnology to develop materials that are lightweight, durable, and resilient to the extreme Martian environment. The focus of our developments is on materials produced in situ using additive manufacturing technology (3D printing), such as the use of Lunar and Martian materials.

Results: The research conducted by the team aimed to pave the way for sustainable human exploration and settlement of Mars. By developing and utilizing innovative materials and technologies, the team aspires to enable a new era of space exploration and technological advancement. The findings of this research have the potential to revolutionize the approach to Mars exploration, facilitating long-term habitation and overcoming the challenges posed by the harsh Martian environment. The results emphasize the significance of interdisciplinary collaboration and highlight the importance of STEM education in driving advancements in space materials science and engineering. We will also discuss the challenges associated with producing and transporting these materials to Mars, as well as the potential applications of these materials beyond space exploration.

In conclusion, our research endeavors aim to lay the foundation for a future where humanity can thrive on Mars, leveraging innovative materials and technologies to overcome the challenges of the Red Planet and unlock new possibilities for exploration and scientific discovery.

## Outreach

Alessandra Calanchi

An unexpected visitor: The man from Mars and his interplanetary moral code (V)

In 1891, The Man of Mars: His morals, politics, and religion was published by William Simpson in San Francisco. It told of a visitor from outer space who advised a terrestrial man about the risks of civilization. After choosing Unveiling a Parallel by Alice Ilgenfritz Jones and Ella Merchant for 2021 conference and Journeys to the Planet Mars by Sara Weiss for 2022 conference, this year Badioli and I want to speak of Simpson’ novel, which is as utopian as the former ones though more focused on technology and politics. The Martian of the title travels to Earth thanks to a teleporter ray or hologram ante litteram, but there are other surprises for us modern readers…

Karoly Schosser

Process-based behavioral interventions for enhancing performance in AMADEE20 (V)

Humansys

A series IAC papers discuss and show the theory and evidence of process-based cognitive-behaviour therapies (CBTs) including mindfulness, and acceptance and commitment therapy (ACT) (Decadi & Schlosser et al 2018

Schlosser 2020a

Schlosser 2020b

Schlosser & Lucic, 2021

Schlosser, Antonova & Petrut, 2021

Schlosser & Whiteley, 2022). Some of the relevant data resulted from a landmark pilot study discusses the benefits of modern organisational development interventions using process-based CBT with ISS flight controller teams (Schlosser, 2020b). In this current study, we evaluate the results of a brief ACT team-building intervention of crew members, flight controllers and support staff serving together in the AMADEE20 mission for a month (N=25). We will discuss how key psychological processes impact mission critical outcome variables including performance, mental health, team cohesion and autonomy. The data collected during this quasi-experimental study benefits from an intensive longitudinal design with 25 timepoints to monitor changes in participants over time and partially compensate for the low sample size. The significance of this pioneer study is that (1) it evaluates the utility of leading-edge forms of CBTs in the space industry

(2) for the first time it focuses on the complete operative team, regarding the flight controllers and support staff just as important as the analog astronaut crew

(3) speaks from an organisational development perspective when aiming to boost mission critical outcomes

(4) serves as a compelling behavioural health framework for future human behaviour and performance trainings.

Libby Hubbard

 Mars for all - Arcology for all

Lovolution Studios

The Mars Society has inspired two books edited by Dr. Frank Crossman: MARS CITY STATES New Societies for a New World and Mars Colonies: Plans for Settling the Red Planet. In these books, the imagination is set free to explore the realms of utopian thought, not only in technological advancements but in revolutionary lifestyle patterns. Martian human habitats differ from the urban development pattern known as the American Dream, the single-family suburban house and private car that promotes hyper-consumerism. Our current development structure destroys critical habitats for wildlife and is a source of industrial pollution.

The late architect Paolo Soleri coined “arcology,” a fusion of architecture and ecology. He devoted his life to building a prototype at his urban laboratory Arcosanti, west of Phoenix. Arcosanti’s high-density, frugal design is an implosion of the city, an antidote to Phoenix’s resource-wasteful urban sprawl of the “Great Acceleration.”

Soleri’s booklet What If? #5 Ecominutiae explains his Space for Peace art series. These consist of collages depicting his vision of extraterrestrial colonization within space arcologies, what Soleri calls Ecominutiae, defined as ecological pods or micro-biospheres. Soleri’s earth arcologies have the potential to become space arcologies.

Since Soleri’s death in 2013, the Arcosanti project has been searching for a way to complete its vision of attracting a critical mass of 5,000 people. Soleri writes, “Development toward Critical Mass will likely call for the input and cooperation of appropriate agencies, such as universities, foundations, and other groups engaged with questions of social-cultural and environmental concern.” [Soleri, “What If? Arcosanti Genesis, 2008]

In this talk, I will ask, what if the Mars Society takes steps to ground the Martian paradigm shift in space architectural design on Earth? What if the Mars Society partnered with the Arcosanti project and made it their hub for conducting the “noble experiment?” The Arcosanti project could be a bridge between Earth and Mars, a place to prepare future Martians to live frugally within planetary boundaries.

In such a partnership, The Mars Society could spearhead the urgent need to experiment with collective living and a circular, automated economy starting with 1,000 evolutionary pioneers. The conference theme, “Mars for All,” becomes “Arcology for All,” a shift in shelter for all.

In this talk, I will present the fundamental principles of arcology, an evolutionary architectural design for sustainable life in the 21st Century.

Charles Leatherwood

The Mars Leap brings the dream of Mars to a new generation

The Mars Leap

When Apollo went to the Moon, every person on the planet knew their future lay in space. Today, though Humanity’s returning to space, the dreams don’t seem quite the same. But what if we could give millions of people the chance to go to space for themselves… what would the dreams be like then?

The Mars Leap, sponsored in part by The Mars Society, offers the chance for people to join a team of astronauts exploring Mars. In person. For themselves. It’s a totally immersive educational experience designed to travel to science centers across the country and inspire a new generation with the dream of space. But the Mars Leap does more than just build dreams, it gives people the educational and professional tools to make their futures in space a reality.

The Mars Leap can help build the educated workforce and broad political support Humanity will need to reach to Mars and beyond. We’re actively fundraising now, giving everyone from individual Mars advocates to the largest space companies a new way to advance our common space agenda.

Please join us to find out what makes The Mars Leap such a groundbreaking educational and inspirational exhibit, the new ways it connects visitors with educational and employment, how sponsorship can benefit your company, and some of the ways we’ve been introducing The Mars Leap to the world.

Ed Heisler

Hello Mars: Here We Come!

The Mars Society

As a result of the work by so many we have made considerable progress in building the only international organization dedicated to promoting the direct human exploration of Mars.

Due to our pioneering role, we are in an outstanding position to enter a new and exciting phase of our work.

Just look at some of the many programs we have initiated:

• The first analog Mars Desert Research Station

• The reopening of our Flashline Mars Arctic Research Station

• The University and European Rovers Challenges

• Our Mars Society social media websites

• Marspedia, our collaborative resource for exploring and settling the Red Planet

• The Mars VR Project

• The Mars Society YouTube Channel with hundreds of videos from our convention plenary sessions and “Trac” presentations

• The Mars Papers archive

• Our “Red Planet Live” podcasts

• Our Mars Society Ambassador Program

• Our Annual Mars Society Conventions

We have the tools ready to expand our reach and improve our effectiveness in promoting Mars Society activities.

And we have begun reaching out to the growing population that favors sending human explorers to Mars. This was clearly demonstrated by our welcomed participation at the August Las Vegas Star Trek convention where we had a display booth, a MarsVR demonstration room and a presentation to over 300 people by our President, Dr. Zubrin.

We along with tens of millions of people from all over the world love Star Trek’s positive and optimistic vision of humanity’s future, a vision of a much longer, happy, and productive life for all, a society free of racism, anti-semitism, sexism and all forms of anti-science bigotry. That future planet-wide democratic economic and political system does not exist now and doesn’t have a name yet. But I am sure we’ll come up with a good one. Marsism?

Narcisse Mbunzama

Enhancing STEM Education in Africa to Support Red Planet Exploration (V)

Digital Security Group

The exploration and potential colonization of Mars, the Red Planet, stand as a monumental scientific and technological undertaking. As humanity sets its sights on this ambitious endeavor, it becomes imperative to harness the untapped potential of Africa's youthful population through enhanced STEM (Science, Technology, Engineering, and Mathematics) education. This abstract highlights the crucial role that bolstering STEM education in Africa plays in the global pursuit of Martian exploration. By investing in quality STEM education, Africa can cultivate a skilled workforce capable of contributing to the development of cutting-edge technologies, sustainable habitation solutions, and innovative scientific research required for successful Red Planet missions. Moreover, such investment not only aligns with the spirit of international collaboration but also positions Africa at the forefront of scientific advancement, paving the way for socioeconomic growth and technological leadership on a global scale.

Jemimah Kwakuyi

 Empowering Exploration: My Journey as an African Female Volunteer (V)

The Mars Society-Volunteer

The pursuit of human exploration beyond Earth's boundaries has captivated our collective imagination for generations. As we venture towards distant horizons, the Mars Society has taken a remarkable stride by establishing Mars analog research stations that simulate the challenges of living and working on the Red Planet. This online presentation delves into my unique journey as an African female volunteer, contributing virtually to the Mars Society's groundbreaking research stations.

In a world increasingly interconnected by technology, my involvement transcended geographical limitations, allowing me to partake in this cutting-edge initiative from the heart of Africa. This presentation recounts my experiences, challenges, and triumphs as a remote volunteer, leveraging digital tools to provide critical support to the Mars analog research stations. From facilitating communication between on-site crew members to remotely troubleshooting technical issues, my role exemplifies the potential of global collaboration in advancing space exploration.

Drawing from personal anecdotes, interactions with the Mars Society's diverse team, and insights gained through this virtual endeavor, I explore the broader implications of such international cooperation. We examine how virtual participation can democratize access to space-related opportunities, allowing individuals from all corners of the world to contribute meaningfully to the exploration of other planets. Additionally, I highlight the significance of gender diversity and representation in space-related fields, sharing observations on the contributions of African women in shaping the future of space exploration.

As we move forward into an era of unprecedented technological innovation and space exploration, my journey exemplifies the transformative power of virtual engagement. By narrating my experiences as an African female volunteer for the Mars Society's Mars analog research stations, this presentation aims to inspire others to embrace remote collaboration, bridge geographical divides, and contribute to humanity's bold quest to reach the stars.

# SATURDAY SESSIONS

## Special Presentations

Using desert varnish at Mars analog sites as a model for life detection on other planets

Shannon M. Rupert, Ph.D.

The Mars Society, U.S.A.

 Desert varnish is patchily distributed material coating rockfaces in arid environments. It consists of clay substrate that has a higher Mn/Fe radio than what is normally found in the Earth’s crust and is it populated by microbial taxa. Studies have determined that it is physically composed of both chemical and biological elements. Some studies argue that these patterns, while naturally occurring, are chemically mediated and then are colonized by opportunistic microbial life. Others argue that desert varnish shows signs of biological mediation at its origins and that the chemical components came after this colonization. Desert varnish gives us the opportunity to examine the origins and identity of a possible biosignature on Earth that has not yet been conclusively identified. In our search for life on other planets, we will be using tools that we develop on Earth to detect life, but what do we did in a case where our technology fails us? We may need to revisit the fundamentals of life and use ecological analysis as a means to know if a possible lifeform exists and should receive additional investigation. We are working on a study that looks at the ecological niche occupied by desert varnish to further test the hypothesis of a biological origin.

## Science

Quinn Morley

Drilling Deeper: Borebots and the Search for Life under the ice (V)

Planet Enterprises

Robotic deep drilling is an important emerging technology for subsurface access in key locations of the solar system, and will play a pivotal role in the search for life in the coming decades. Mars, as well as the more than a dozen ocean worlds (including Titan, Enceladus, and Pluto), are prime targets for subsurface exploration in the search for a second genesis of life, or for unveiling panspermic connections between all life. These planets, each with unique characteristics and challenges, present an opportunity for the development and deployment of self-driving drilling robots (borebots) at various scales. This presentation explores potential future scenarios which may be enabled by borebot technology, speculating on how deep drilling could shape the future of space exploration, and potentially transform our understanding of life in the universe.

The exploration of Mars' deep subsurface ice using borebots is an innovative method to overcome the limitations of traditional electromechanical drills which are cable-suspended and constrained by a physical link to a surface lander. By using several borebots in a sequential operation, mechanical wear can be evenly distributed, and borebots can recharge between trips. This flexibility also provides the opportunity to initiate additional boreholes at new drill sites when desired, or to recover from a catastrophic loss of downhole equipment.

This technology's potential extends beyond Mars: from deploying one-meter-diameter borebots to access Titan's subsurface ocean, to using ten-meter tunnel boring robots serviced by swarming support wall-crawlers on Enceladus, or by employing a descending-diameter borebot architecture on Pluto, borebots present a versatile family of potential solutions to complex subsurface exploration problems.

The objective of this work is to shift the perspective within the space community about deep drilling missions and to inspire and educate the next generation by considering bold deep drilling missions targeting these subsurface domains.

Gabriella Rizzo, Jan Spacek

The past and planned missions to Mars from the Astrobiological perspective

ALFA Mars

In the quest to explore and understand Mars a series of 50 missions have been flown there. Starting in the early 1960 Soviet Union attempted to send a series of Marsnik and Sputnik flyby missions, however the first to successfully fly by Mars was NASA’s Mariner 4 in 1969. Preliminary data from the follow up Soviet and US missions hinted that life might be present on Mars. It was no surprise that the first orbiters and landers had as the main objective to look for the holy grail of space exploration, an active life on Mars. Viking 1 and 2 landed on Mars in 1976 and the first results from the Mars biology experiments were interpreted as positive - Mars holds alien life! However, subsequent experiments from the mass spectrometer failed to find any organic materials. This reversed the previous result interpretation, following this logic: Life cannot exist without organics. Mars lacks organics, therefore there cannot be life on Mars. Mars was dead again and no more missions to Mars were flown by NASA for almost 2 decades. When it restarted in 1990 the search for active life was no longer the goal.

When Curiosity discovered organics in Mars soil in 2013, the logic of the negative interpretation of the Viking results should have been revised again. Yet surprisingly the space exploration culture has not changed. To this day no mission to Mars looks for active life on Mars and planned missions until the 2030s would not be able to conclusively find life on Mars. If NASA follows through on its current plans, we might send humans to Mars before we know if it hosts indigenous life.

This talk reviews the capabilities of the past and planned missions to find Martian biosphere including planned missions by ALFA Mars.

Art Harman

Is China Winning the Race to the Moon? Does it Matter?

SaveMannedSpace.com

Delays in building and testing NASA’s SLS and SpaceX’s Starship HLS have ended the prospects for a crewed landing on the south lunar pole before 2026. At the current pace, Artemis III may not launch before 2027 or later. Meanwhile, China is moving at Apollo-like speed to beat the U.S. because of their openly-stated goal to claim the Moon, or at least the water-ice-rich polar craters as theirs, following their violations of law in seizing the sovereign territories and international waters of the South China Sea.

You’ll learn the latest about China’s space program. Their new Long March 10 rocket and their SLS-lookalike LM-9 rocket, their lunar mission profile, and more. You’ll learn about their new reusable rocket designs and plans for a Starship clone. You’ll also learn why potential Chinese dominance of space matters so much to free world and commercial access to space. What’s the view in Congress and NASA about China’s plans? Could that affect the budget and timing? How might the next presidential administration view space exploration and our goals for landings and permanent bases on Mars?

Holger Isenberg

Modern Martian Mysteries

areo.info

Water and organic chemistry are the most frequently appearing topics in press releases about Mars today, but they weren't even surprising for models existing decades ago. More interesting discoveries not explained by any theory yet have been made recently by various missions and are barely discussed in public science. This presentations will provide an overview of a few of those:

Ingenuity Helicopter portrayed an X-shaped permanent xerography-like image left in the shape of its resting rotor blades on the surface in 2021. In the same year, a video sequence from Perseverance Rover Navcam showed a rapidly expanding km-wide dust torus on the surface defying the available energy of thermal-based convection. Earlier already in 1976, Viking Orbiter provided true color images of bright blue-green spots in some craters which were confirmed by hyperspectral images from Mars Reconnaissance Orbiter CRISM in 2023 as not being imaging artifacts. In addition, signs of electrochemistry causing deposits of perchlorates and unexpected amounts of metal dust deposits in the atmosphere have been observed in 2008 and 2014.

Steve McDaniel

Fast & Cheap, Wide & Deep

Reactive Surfaces

On a timely basis (before we’re dead) is there any way to prove life exists outside Earth? Maybe. The presentation will discuss “Life-Seeking Planetary Penetrator Probes, . . . US Patent No. 10,718,750.

The idea was “Fast & Cheap, Wide & Deep . . . with devices and methods for detection of evidence relatively near the surface of extraterrestrial bodies (e.g., Mars, Venus, Ganymede, Europa, watery asteroids, etc.) described. In particular, a ground penetrating probe (“deep”) based on military bunker-busting technology and capable of conducting life detection or other experiments and transmitting the data from the experiments to a satellite relay is proposed that eliminates false positives using reactive coatings with various functionalities (anti-microbial, anti-fungal, anti-biofilm, self-cleaning, self-sterilizing, nucleic acid free surfaces). Methods of use for such devices and apparatus are proposed that are economical (“cheap”). These penetrators can easily piggy-back on probes already in design and production headed to various corners of our star system (“wide”). The hardware and materials already exist (“fast”).

The technology will be licensed at no cost to any exo-targeted spacecraft, orbiter, lander. My labs at Reactive Surfaces will provide technical support at no cost. Maybe, if the Mars Society was interested in promoting the concept, it could be in charge of reaching out to entities with spacecraft “on the books” to fly the probes.

William Gardiner

Mars Mysteries Become Discoveries Providing a Rationale for Bootstrapping Improved Habitability

Analytech

The unexpected transmission of metallic ions to the ionosphere of Mars by the passage of Comet Siding-Spring in October 2014 raised the possibility of an overlooked natural process that could be exploited to improve Mara habitability. Traditional terrestrial geology provides three major origins of all forms of minerals and the molecules of life including water. These are igneous, metamorphic and sedimentary. But the event not only at Mars but between the solar plasma, comets and some asteroids that are stimulated to become electrified and therefore cometary in behavior suggest a more fundamental process. We may refer to this process as plasma deionization or as anionic-cationic electrochemical formation. This class of formation appears to be a more general process in the solar system/heliosphere than a chance delivery by intersecting bodies. Data collected both of the terrestrial mesosphere and at the appropriate atmospheric height on Mars where meteors are observed show that the abundance of metallic ions are of stream dust are instead dominated by high rate constant deionization processes described as a sink of remotely sourced cations or anions recombining with locally sourced, oppositely charged cations or anions. Precipitation with locally sourced anions or cations occurs through well understood processes of recombination and neutralization. The conditions of recombination result in some excess kinetic energy that accounts for their appearance as moving "meteors" in the upper atmosphere at both Earth and Mars. In the rarefied atmosphere of Mars, surface recombination effects may be possible, explaining the Martian “blueberries” and the blue-green “smudges'' associated with craters photographed by the Viking orbiters and more recently by the CRISM instrument aboard MRO. Ongoing work by Leif Holmlid at the University of Gothenberg with condensed ”Rydberg matter” may be enhanced as substrates for the molecules of life, such as amino acids and phycocyanines.

Ian McCann

The Uniform Martian Land Survey System (UMLSS)

While the surface of Mars has a system of latitude and longitude to describe points, and is divided into thirty quadrangles established by the United States Geological Survey, it currently lacks any unified system to describe smaller areas. Inspired by the Public Land Survey System (PLSS), the Uniform Martian Land Survey System (UMLSS) assumes that the Martian surface is perfectly spherical and divides it into townships and sections, which can be divided at will to describe parcels of any desired area. Provision is made for correction latitudes to account for the curvature of the Martian surface, townships and sections located near the poles and antimeridian, and any modeling discrepancies between the system and the actual Martian surface.

SANDHYA RAO

TO STUDY CARBON DIOXIDE AND POLAR ICE CAPS ON THE RED PLANET

VIMANA NOTION DESIGN TEAM

To study the frozen Carbon Dioxide (Dry Ice) and the dust particles.. As there is both water ice and also CO2.. The research cycle of condensation and sublimation could tell us more about the evolution of the Martian climate.. To develop scientific Instruments and futuristic observations of the Polar ice caps and co2 snow during the entire Years of Mars that is 687 Earth Days. To understand the features such as araneiforms form and change, with seasonal polar ice caps varying under changing conditions To study, The entire process the past and present climates and environments of Mars and how they evolved.. This would assist in building up the lander and also IIce rover which would perform different activities apart from the Polar ice caps and CO2. Different Scientific Instruments would detect the weather phenomena that can influence CO2 snowfall and vaporization on Mars.. To study the dust particles and sand which could assist the researcher to conduct more experiments.

Carl Greenbaum

A Dragonfly for Mars

Mars rovers from Pathfinder to Perseverance have produced great science. However, slow transit speeds, difficult terrain and the sol-to-sol command sequence limit their effectiveness. The helicopter Ingenuity gave us a taste of the exploration enhancement available with the mobility and flexibility it provided. However, as a technology demonstration, the hover time was limited to 30 seconds and the science payload was miniscule.

Meanwhile, back here on Earth, the Dragonfly Program was approved to fly a large science helicopter on Saturn’s moon Titan. With an atmosphere 1.5 times the density of Earth’s, the octo-copter Dragonfly will explore this region in short flights, building up to a series of longer “leapfrog” flights of up to 8 kilometers, stopping along the way to take samples from compelling areas.

Is there any chance we could develop a Dragonfly-like mission in Mars’ tenuous atmosphere? Starting with the JPL Mars Science Helicopter design and variants of existing instruments we could have a unique Mars exploration system, a Damselfly. Science instruments would include lighter weight versions of the RIMFAX Ground Penetrating Radar and SHERLOC (Scanning Habitable Environments with Raman & Luminescence for Organics & Chemicals) used on Perseverance. The principal development challenge will be a new power source, a micro-RTG. Polonium 210, with a power density of 140 W/g and a half-life of 138 days would be ideal for this application. As a pure alpha emitter, shielding requirements are modest. Very small RTGs have been developed in the past, even small enough to power a cardiac pacemaker.

Since the JPL Mars Science Helicopter was designed to fold into a 2.5m diameter backshell, the well tested airbag assisted EDL technique as used for Spirit and Opportunity can be used. Given the low system mass, four Damselflies could be launched to a Mars intercept on a single Falcon 9.

## Analog Research / NewSpace

Alexis Lojek

Digitally Assessed Measurement of Stress in an Analog Astronaut Environment: Trends and Potential Mitigations

APUS Analog Research Group

Experiments were conducted to assess whether heart rate variability-based digital measurements of stress using wearable devices were helpful in monitoring stress before, during, and after three analog astronaut missions, to determine if a mitigation technique in the form of scheduled times to stop, breathe, and focus on the breath could help reduce stress, and to observe any trends in the data. Stress data of 14 crewmembers across the 3 analog astronaut missions was gathered and crewmembers were scheduled to stop and breathe for a predetermined amount of time to determine if there was an instantaneous reaction during these sessions as well as a longer-term reduction in stress.

Crews were not found to have an overall reduction in stress during the days when focused breathing was conducted, but the techniques did lower stress instantly. They were also found to have lower stress levels when in the analog environment than when not, and the use of digital devices provided an easy, noninvasive way to assess crew stress levels. Further research in this area is warranted as it could have possible implications beyond space, including not only the military, but also Arctic and Antarctica expeditions and other extreme environments, everyday employment, and life.

Boris Petrovic

Virtual Reality and Metaverse Applications for Mars Habitat Simulation and Training

ExoTesla

ExoTesla Sim is to be presented - developed as a Virtual Astronaut platform for educational and training purposes. We present the use of Virtual Reality in Parametric Martian Habitat simulation and training and Metaverse technologies for wider adoption of space science and exploration. Conversational Artificial Intelligence applications in Virtual Astronout multi-user environment is developed to facilitate simulation scenarios. Generative AI, both text and graphics for multilingual immersive interaction and presentations of virtual being Mars analog astronauts non-human characters. Parametric Space Architecture back-end software and pipeline is used to generate Martian habitats from templates with the goal of studying organization of space in various simulation scenarios. An interface to synthetic data provided by "SIMOC - A scalable, interactive model of an off-world community" is developed to drive the data-driven habitat simulation engine of ExoTesla Sim. Scalable models of off-world settlements are provided for immersive interaction in virtual reality. A collection of Exotesla Sim Space GIS applications is provided in an integrated system architecture to give a real-world experience and further space development. The ExoTesla Mars Metaverse multi-user platform can facilitate knowledge exchange and discussion on Mars science themes among members of the Mars Society, foster collaboration and networking opportunities among participants, promote the use of emerging technologies, such as VR, for enhancing the understanding of Martian landscapes and habitats and encourage dialogue on the future of Mars exploration and Mars Village concepts.

## Technical

Fedor Karpelevitch

The Case Against EVA suits

Author argues that EVA suits are a dead-end technology due to the inherent conflicting requirements. Instead of pursuing development of EVA suits, the author suggests that time, effort and resources would be better spent developing solutions that solve the problem that EVA suits are trying to solve much more efficiently. Thinking from first principles, the actual problem we are trying to solve is enabling a human explorer to operate in a hostile environment. However EVA takes a naive approach to solving this problem by attempting to make the environment survivable while trying to preserve the (illusion of) human autonomy. Pursuit of this illusion creates a solution that is bad at both things it is trying to achieve: making the human comfortable and making the human efficient (not to mention economics and such).

Author proposes remote-controlled robotic avatars, pressurized rovers with external manipulators or similar approaches as alternatives. Most importantly, the author urges mission planners to “think outside the EVA suit”.

Robert Mills

Virtual Telerobotics & AI for Mars

MIFECO

Virtual Telerobotics can be used to create training scenarios for Artificial Intelligence (AI), to mitigate planetary communications time delays, and for human collaboration with robotics. All of these will be needed to support robotics for Mars exploration and infrastructure deployment. Particularly using semi-autonomous robotics collaborating with human operators on Earth and within Martian habitats. During this presentation we will describe and expand on these scenarios, discussing how we can use existing data and data from on-site robotics sensors to create virtual analogs of the Martian surface, robotics, operator interactive controls, and surface infrastructure. Using these with VR tools, gamification, and foundational models we will show how this can provide AI training, help develop real-time human collaboration, and help mitigate interplanetary communications time delays.

John Chapin

Mars-Standard Control and Data Systems

Life on Mars will depend on automated machinery. Automation requires control systems and data storage. Short term survival requires having enough spare parts to replace failed components in the controllers, and enough spare copies of the data to survive destruction of a few CD-ROMs or thumb drives. Long term survival requires the ability to manufacture the necessary spare parts and duplicate the data storage media on Mars.

 To summarize, the Mars community needs to act along two paths in the near future. To reduce sparing requirements and facilitate on-site repair requirements for early missions, we need to set Mars Survivability standards for first-generation control equipment that promote use of common parts and repairable boards. The time to act is now since ISRU plants and other developments are starting. To enable long-term sustainability, we need to explore and experiment with an Earth-independent low-tech ecosystem and supply chain for automated control, then transition those lessons into design requirements on second-generation equipment.

Tommaso Batacchi

Mars in-situ Propellant Production

This Master's Thesis (Delft University of Technology) delves into the design and modeling of an in-situ rocket propellant production plant essential for refueling SpaceX's Starship for Earth return missions. By focusing on In-Situ Resource Utilization (ISRU), this study identifies optimal design practices for the propellant production plant and explores its integration with cutting-edge technologies.

A paramount aspect of this research is the exergy analysis of the plant to gauge its second-law efficiency. Uniquely, this work develops a methodology for conducting exergy analysis under the divergent standard conditions present on Mars. Additionally, the study investigates material recycling, sensitivity analyses, leveraging the Martian environment, and heat recovery prospects within the plant's framework.

As an outcome, this research presents a model of a full-scale rocket fuel production plant. This model embodies the synthesis of current best practices and technological advancements, providing invaluable insights for the future of Martian exploration and colonization. In essence, this research significantly contributes to the realization of a sustainable ISRU rocket propellant production plant, which is indispensable for ensuring return missions to Earth.

Bruce Mackenzie, Doug Plata, Daniel Tompkins

Live in a Mars/Lunar Settlement, on Earth

Mars Foundation, Space Development Network

We invite you to live in a Mars Settlement, right here on Earth.

Bring the whole family. Let your kids make a pizza from plants they harvest in the Mars Greenhouse. Or, drive rovers. Contemplate the space toilets. Go next door to the Lunar workshops to see what can be made from Lunar or Mars materials. They can compare Lunar and Mars gravity for sports in the elastic jumpers. Your kids will sleep in the frontier style Mars Homestead (™) hab quarters, easily jumping to the top bunk. Meanwhile, the parents enjoy the future furniture in their room, made from locally produced Martian fiberglass. The furniture is made from local Mars plastics made from “thin air”. Try your hand at laser cutting your own furniture, or 3D print small kitchen utensils of Mars bioplastic to take home. Older kids at summer camp try remote equipment repair up on Phobos, Learn to actually make their own plastics, bioplastics, rocket fuel (and explosives?). College students who might otherwise take a semester abroad, have a semester off-planet instead. They take courses in Mars agriculture, architecture, geology, astrobiology, etc. And join the research groups of professors on sabbatical. If you don’t have much time, just take the ‘Living History' tour, hosted by future space settlers showing how they live, grow food, and build their living quarters. The settlement can also be rented for corporate retreats, weddings, conferences, and other special events. Two sites being considered are near the launch sites at Boca Chica and Florida, so your visit may include a tour and launch. Oh, incidentally, we will also have test equipment, such as dusty pressure chambers, for new-space companies to test and demonstrate their prototype space equipment. All open for public viewing when appropriate.

How to make this happen?

Note this is an analog of a permanent settlement, constructed from local materials. That differs from the Analog Bases such as MDRS. It is unique, not in competition with them.

We seek partnerships with space groups, commercial companies, universities, land investors, hotels, restaurants, and government agencies. For example, an agricultural company would sponsor a greenhouse. Already built is the ‘InstaBase’, a full-size Moon-Mars analogue base for illustration purposes. (Being made of plastic, it is just a demo for testing scale and layout.) We plan to make follow-on designs from more durable materials. This is under the direction of Doug Plata and the Space Development Network and Mars Foundation. It has been set up at Boca Chica, and might be viewable at this conference.

Join this Analog Settlement project. It is in the planning stage, so your ideas can influence the fundamental designs. Contact: BMackenzie@alum.mit.edu 781-249-5437

Tim Heilers

Mars Unix Time: It's Time, for Mars

What time is it on Mars? This is probably the second most asked question about the planet after the question of life on Mars, be it extant or ancient. Nearly every aspect of every mission from when to launch, to what season to prepare for, to when the next status update is due relies on knowing exactly where Mars is both in relation to its orbit around the sun and in relation to those of us watching and waiting here on Earth. As time goes on and we begin to live and work on Mars, the question of time on Mars is only going to become more pertinent and personal.

Until now, deriving the time on Mars has involved convoluted calculations with variables such as Solar Longitude and Mean Anomaly. But what if there was a simpler way. What if it was as simple as a Unix timestamp? A single number that, when interrogated properly, will tell you not only the time of sol, but sol of the week, month, and year. And if you share your longitude with this number, it will give you the local solar time anywhere on the planet. It is calendar agnostic. It can give you the Mars Sol Date just as easily as the Mars Julian Sol. It’s compatible with every factual and fictional Time Zone scheme I could find to throw at it, including one I created myself.

The best part of it all is there is no need to reinvent the wheel. The only thing you need to find Mars Unix Time is a plain old UTC timestamp. This can rapidly and easily be done on practically any hardware manufactured on Earth and sent to Mars.

SANDHYA RAO

TO STUDY RADIATION IN MARS

VIMANA NOTION AEROSPACE DESIGN TEAM

The environment conditions on Mars are very important for the design of photovoltaic systems for establishing outposts on the Martian surface. The mission is to carry out the power program and is aimed at providing ultra-light weight photovoltaic array technology for such applications as well for Lunar/Mars surface. Detailed study and information on the climate conditions on Mars at specific photovoltaic systems are very important. This paper addresses the variation of solar insolation. The scientific radiation data is based on measured optical depth on the atmosphere of Mars which derived from Sun and calculate the computation based on multiple wavelengths and multiple scattering of the solar radiation. This database could be provided to scientists and astronauts for the operations. This data can be used to make estimates of photovoltaic system power area and mass for a surface power time using regenerative fuel cells for nighttime operations and storage. We also study the global and local dust systems and their characteristics.

Karoly Schlosser

AQUANAUTA CE'S FIRST CAVE DIVING MISSION - A HIGH-FIDELITY ANALOGUE APPROACH TO SPACE EXPLORATION

Humansys

Aquanauta CE (www.aquanauta.space) organises cave diving missions as space analogues with the purpose to study behavioural health of expert explorers in an environment, which has high-fidelity to contemporary and future space exploration goals. In this interactive presentation we will give a peak into our first mission performed in 2021, May

alongside some of the key outcomes in these extreme, confined, isolated underwater venues. We believe high fidelity contexts like cave, technical and commercial diving has higher level of realism to space exploration, and in some respects can be a better alternative to desert-based analogues. In particular, behavioural health research may even have higher face validity to "traditional" approaches due to the high task complexity, the expertise required, and the environmental, psychological and physiological stressors involved. We look forward to connecting with future partners and those who may be interested to potentially invest in what we do.

## Student Mars Debate

From September 30th/October 1st, The Mars Society and Debate to Educate will pair up for a one time only spectacular event! Teams from all over the world will debate some of the most crucial scientific questions of our time, competing for a chance to perform virtually in a final round at the Mars Society Convention in front of an audience of some of the greatest minds in the field of space exploration!  We will be offering $1000 in cash prizes (minimum), to be distributed amongst the top 2 teams in each division.

We will match competitors in ANY time zone, so that all debaters may compete at a reasonable time between Saturday, September 30th and Sunday, October 1st

Our tournament will be practicing World School Styles. All debates will be in English. Each team may consist of 3-5 debaters, and will compete in 3 rounds, with the possibility to compete in a final. All teams must provide a judge.

Teams are not required to be from the same school. We will be hosting both Middle School and High School students!

Middle school teams must have an average age of under 15 years old. Each speaker should speak for 4-7 minutes in order to avoid time penalties. Each speaker is required to accept a minimum of 2 POIs.

High school teams must have an average age of under 19 years old. Each speaker should speak for 7 minutes in order to avoid time penalties. Each speaker is required to accept a minimum of 2 POIs.

All motions will be prepared and announced at the time of the round. Our motions for the tournament are as follows:

1. This House Believes there is life on Mars

2. This House Believes Mars would best be explored through robots (as opposed to humans).

3. This house believes the settlement of Mars should be led by private companies, and not by governments.

4. This house believes the first human mission to Mars should be a no-return mission.

5. This house believes humans should attempt to terraform Mars.

# SUNDAY MORNING SESSIONS

## Special Presentations

**A Summary of the First Two Crews at the Sealed and Pressurized SAM**

**Kai Staats**

**University of Arizona Biosphere 2**

SAM: A Space Analog for the Moon and Mars (SAM) is a hermetically sealed and pressurized habitat analog and research facility located at the renowned University of Arizona Biosphere 2. It is composed of a variable volume pressure regulation chamber, controlled environment (greenhouse), engineering bay, and crew quarters complete with sleeping quarters, kitchen, bathroom, and fully functional airlock, all contained within the pressure envelope.

This paper and presentation will pick up where the presentation to the Mars Society in 2022 left off, with a brief summary of the extensive effort to complete the SAM facility, a visual tour, and an overview of the mission objectives and conclusions of the first two, successful missions.

These mark the first pressurized analog habitat experiments on the Biosphere 2 campus since 1994, and the only hermetically sealed and pressurized habitat analog in operation anywhere on Earth today. The use of a pressure vessel forces an imperative close monitoring and management of air quality and pressure regulation, both of which will be discussed. SIMOC Live was employed as the means to monitor oxygen, carbon dioxide, temperature, relative humidity, and pressure as reviewed daily by SAM’s Mission Control, and delivered to the embedded crew with a full narrative.

Mission objectives included procedures for dust mitigation following an EVA, sample returns, in-field electronic repair, air quality monitoring, 3D printer assembly and subsequent printing of a 3D map for a blind crew member, analysis of the acoustics of the varied spaces, water reuse and recycling, care for plants in a hydroponics grow chamber, and more ...

One crew member for both Inclusion I and Inclusion II is blind, and provided valuable feedback to improve the facility for future blind crew members. In the adjacent prototype Mars yard SAM supported what is believed to be the first movement through a Mars yard by a blind person wearing a full pressure suit and navigating only by cane. All four members of each crew were successful in their respective EVAs.

**Generative AI for Citizen Scientists**

**Erik Bethke**

**Million on Mars, Inc.**

Inspired by Dr. Robert Zubrin's tractable framework for settling Mars -- Food (Biotech), Labor (AI), and Energy (Nuclear) -- this talk unveils the transformative role of Generative AI across multiple domains.

Exploiting daily interaction with tools like ChatGPT, Midjourney, CoPilot, Codeium, Cursor, and Scenario, the author has catapulted productivity at Million on Mars by an order of magnitude. This hands-on experience serves as a real-world testbed demonstrating AI's expansive utility.

Key Takeaways:

Generative AI as Creative Lever: Boosting productivity by an order of magnitude, Generative AI liberates researchers and citizen scientists for true creativity; akin to Zubrin's AI as a solution for labor. For the author, this has led to substantial gains in game design, software engineering, and content creation.

Efficient Learning & Decision Making: Just as Biotech optimizes food production, AI can summarize vast academic fields, facilitate interactive Q&A, and create "survey papers" on the fly, accelerating our mastery of new subjects.

No More Excuses: With AI handling the mundane, akin to Nuclear providing abundant energy, humans are free to focus on what truly matters. The "Where do you want to go for lunch?" problem scales up, knowing what you desire becomes the main challenge.

This session aims to convert AI skeptics into proactive pioneers. From crafting effective prompts for text and image generation, to exploring research paper summarization and custom oracles, attendees will depart with a toolkit that places Mars within closer reach. Additionally, by participating in abstract generation and automation across diverse forms of output, participants will experience the liberating potential of these technologies.

**Mars Ocean Analogs: Sea Training for Long Duration Space Travel**

**Reid Stowe**

**Maxine Hoover**

**MARS OCEAN ANALOGS, INC.**

Human beings are the weak link in future Mars expeditions. With the looming prospect of astronauts traveling to Mars over unprecedented durations and distances, the importance of addressing the mental fitness of candidate humans to handle such journeys, and achieve mission success, becomes paramount. Reid Stowe, long duration sea captain, holds the record for the longest non-stop voyage in history, surviving and thriving 1,152 days at sea without re-supply. Stowe discusses the Mars Ocean Analog training program that incorporates his unique experiences in overcoming immense challenges at sea, not just to survive, but to function and thrive in an isolated, highly demanding, long duration expedition. Stowe, who has practiced, studied and promoted long duration space psychology since the 1980's, has learned techniques during his many sea voyages that will better prepare, empower and test astronauts as part of their overall space training.

Mars Ocean Analogs, Inc. is newly incorporated 501(c)(3) Nonprofit currently operating in the New York City area.

**END OF ABSTRACTS**

**HAVE A GREAT CONFERENCE!!**

**NOTES**

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